California Instruments

Revision P
June 2007
Copyright © 1997-2007
By California Instruments.
All rights reserved.
P/N 5004-984

Compliance Test System
User Manual
CTS 3.0

TEL: +1 (858) 677-9040
FAX: +1 (858) 677-0940
Email: sales@calinst.com
Web Site: http://www.calinst.com

SAFETY SUMMARY

These power system components contain high voltage and current circuits that are potentially lethal. The following safety guidelines must be followed when operating or servicing this equipment. These guidelines are not a substitute for vigilance and common sense. California Instruments assumes no liability for the customer's failure to comply with these requirements.

APPLYING POWER AND GROUNDING

Verify the correct voltage is applied to the equipment.

Verify that the input power cord to the PACS-X unit is plugged into a properly grounded utility outlet.

Verify that the input power line to the AC power source used is connected to a properly grounded utility outlet.

FUSES

Use only fuses of the specified current, voltage, and protection speed.

Do not short out the fuse holder or use a repaired fuse.

DO NOT OPERATE IN A VOLATILE ATMOSPHERE

Do not operate the system in the presence of flammable gases or fumes.

DO NOT TOUCH ENERGIZED CIRCUITS

Disconnect power cables before servicing this equipment. Even with the power cable disconnected, high voltage can still exist on some circuits. Discharge these voltages before servicing. Only qualified service personnel may remove covers, replace components or make adjustments.

DO NOT SERVICE ALONE

Do not remove covers, replace components, or make adjustments unless another person, who can administer first aid, is present.

DO NOT EXCEED INPUT RATINGS

Do not exceed the rated input voltage or frequency. Additional hazards may be introduced because of component failure or improper operation.

DO NOT MODIFY INSTRUMENT OR SUBSTITUTE PARTS

Do not modify these instruments or substitute parts. Additional hazards may be introduced because of component failure or improper operation.

MOVING THE POWER SOURCE

When moving the power source, observe the following:

1. Remove all AC power to system components.
2. Use two people to prevent injury.

CTS 3.0 Software License

Your CTS Test System was shipped with one copy of the CTS 3.0 software. This software - model number CIC 629- is owned by California Instruments and is protected by United States copyright laws and international treaty provisions. Therefore, you must treat the software like any other copyrighted material.

Software Revisions

Revision codes in the Help About screen of the CTS 3.0 software indicate the current revision. Minor changes to the software such as bug fixes usually do not require a change to the manual. Therefore, the revision number of the software you received with the CTS system may be higher than the software revision number shown below. In this case, the information in the manual still applies.

Software changes that require a manual change will be accompanied either by a new edition of the manual or an errata sheet documenting the changes.

This manual applies to software revision 3.2.0.0 (revision 3.2.0.0 includes the higher speed A/D M Series card from National Instruments and from Exacq Technologies). If you are using a software revision less than 3.2.0.0, contact support@calinst.com for upgrade information. The CTS software revisions can be shown by selecting the Help, About screen.

Printing History

The manual printing date indicates the current edition. The printing date changes with each new edition or update. Update packets or change sheets may be issued between editions to correct or add information. Minor corrections incorporated at reprint do not cause a new edition.

June 2007 Revision P

Trademarks

Windows 2000™, Windows XP™, Windows Vista and MS Excel™ are registered trademarks of Microsoft Corporation.

Contacting California Instruments

To contact California Instruments, use any of the communication channels listed here:

Mail:	California Instruments 9689 Towne Centre Drive San Diego, CA 92121-1964 USA	
Phone:	858 677 9040	7:00 AM - 4:00 PM Pacific Standard Time
	Voice Mail 24 hours	
Fax:	858 677-0940	
Email:	support@calinst.com	
Web site:	www.calinst.com	

WARRANTY INFORMATION

CALIFORNIA INSTRUMENTS CORPORATION warrants each instrument manufactured by them to be free from defects in material and workmanship for a period of one year from the date of shipment to the original purchaser. Excepted from this warranty are fuses and batteries that carry the warranty of their original manufacturer where applicable. CALIFORNIA INSTRUMENTS will service, replace, or adjust any defective part or parts, free of charge, when the instrument is returned freight prepaid, and when examination reveals that the fault has not occurred because of misuse, abnormal conditions of operation, user modification, or attempted user repair. Equipment repaired beyond the effective date of warranty or when abnormal usage has occurred will be charged at applicable rates. CALIFORNIA INSTRUMENTS will submit an estimate for such charges before commencing repair, if so requested.

SERVICE PROCEDURE

If a fault develops, notify CALIFORNIA INSTRUMENTS at support@calinst.com or its local representative, giving full details of the difficulty, including the model number and serial number. On receipt of this information, service information or a Return Material Authorization (RMA) number will be given. Add the RMA number furnished to the shipping label. Pack the instrument carefully to prevent transportation damage, affix label to shipping container, and ship freight prepaid to the factory. CALIFORNIA INSTRUMENTS shall not be responsible for repair of damage due to improper handling or packing. Instruments returned without RMA No. or freight collect may be refused at California Instruments discretion. Instruments repaired under Warranty will be returned either via prepaid surface freight or low cost airfreight at California Instruments discretion. Instruments repaired outside the Warranty period will be returned freight collect, Ex Works CALIFORNIA INSTRUMENTS 9689 Towne Centre Drive, San Diego, CA 92121-1964. If requested, an estimate of repair charges will be made before work begins on repairs not covered by the Warranty.

DAMAGE IN TRANSIT

The instrument should be tested when it is received. If it fails to operate properly, or is damaged in any way, a claim should be filed immediately with the carrier. The claim agent should obtain a full report of the damage, and a copy of this report should be forwarded to us by fax or email (Fax: 858 677 0940, Email: support@calinst.com). CALIFORNIA INSTRUMENTS will prepare an estimate of repair cost and repair the instrument when authorized by the claim agent. Please include model number and serial number when referring to the instrument.

SPARE PARTS

To order spare parts, user manuals, or determine the correct replacement part for your California Instruments products, please contact the Customer Service department by phone at + 1 858 677 9040, press 2 or by email support@calinst.com.

LIMITATION OF WARRANTY

California Instruments believes the information contained in this manual is accurate. This document has been carefully reviewed for technical accuracy. In the event that technical or typographical errors exist, California Instruments reserves the right to make changes to subsequent editions of this document without prior notice to holders of this edition. The reader should consult California Instruments if errors are suspected. In no event shall California Instruments be liable for any damages arising out of or related to this document or the information contained in it.

CALIFORNIA INSTRUMENTS PROVIDES NO WARRANTIES, EXPRESS OR IMPLIED, AND SPECIFICALLY DISCLAIMS ANY WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE OF THIS SOFTWARE AND DOCUMENTATION. CALIFORNIA INSTRUMENTS WILL NOT BE LIABLE FOR DAMAGES RESULTING FROM LOSS OF DATA, PROFITS, USE OF PRODUCTS, OR INCIDENTAL OR CONSEQUENTIAL DAMAGES, EVEN IF ADVISED OF THE POSSIBILITY THEREOF.

This limitation of liability of California Instruments will apply regardless of the form of action, whether in contract or tort, including negligence. The warranty provided herein does not cover damages, defects, malfunctions, or service failures caused by owner's failure to follow California Instruments' installation, operation, or maintenance instructions; owner's modification of the product; owner's abuse, misuse, or negligent acts; and power failures, surges, fire, flood, accident, actions of third parties, or other events outside reasonable control.

SOME STATES DO NOT ALLOW LIMITATIONS ON THE LENGTH OF AN IMPLIED WARRANTY OR THE EXCLUSION OR LIMITATION OF INCIDENTAL OR CONSEQUENTIAL DAMAGES, SO THE ABOVE LIMITATION OR EXCLUSIONS MAY NOT APPLY TO YOU. THIS WARRANTY GIVES YOU SPECIFIC LEGAL RIGHTS, AND YOU MAY ALSO HAVE OTHER RIGHTS WHICH VARY FROM STATE TO STATE.

If any part of this Agreement shall be determined by a court to be invalid, illegal or unenforceable, the remaining provisions shall in no way be affected or impaired thereby.

GOVERNING LAW. This Agreement and Limited Warranty are governed by the laws of the state of California without regard to conflict of law provisions.

INSTALLATION AND / OR USE OF THIS PROGRAM CONSTITUTES ACCEPTANCE OF THESE TERMS AND RESTRICTIONS BY THE USER.

© 1997 - 2007 COPYRIGHT

Under the copyright laws, this publication may not be reproduced or transmitted in any form, electronic or mechanical, including photocopying, recording, storing in an information retrieval system, or translating, in whole or in part, without the prior written consent of California Instruments Corporation.

California Instruments Corporation, © 1997 - 2007

Warning regarding Medical and Clinical use of California Instruments products.

California Instruments products are not designed with components and testing intended to ensure a level of reliability suitable for use in the treatment and diagnosis of human beings. California Instruments products are NOT intended to be used to monitor or safeguard human health and safety in medical or clinical treatment and California Instruments assumes no responsibility for this type of use of its products or software.

Table of Contents

1. Introduction 11
   1.1 Manual Organization 11
   1.2 Compliance Test System Description 12
2. IEC Testing 17
   2.1 About This Chapter 17
   2.2 The EMC Directive 17
   2.3 The IEC 61000-3-2:2000 Standard 18
   2.4 The IEC 61000-3-2 Ed 2.2:2004 Standard 21
   2.5 The IEC 61000-3-2 Ed 3.0:2005 Standard 24
   2.6 IEC 61000-3-3 Flicker 24
   2.7 IEC 61000-4-11 Voltage Dips and Variations 25
   2.8 IEC 61000-4-13 Interharmonics and Harmonics Immunity Test 26
   2.9 IEC 61000-4-14 Voltage Fluctuations 26
   2.10 IEC 61000-4-17 DC Ripple 27
   2.11 IEC 61000-4-27p Three Phase Voltage Unbalance 27
   2.12 IEC 61000-4-28 Voltage Frequency Variations 27
   2.13 IEC 61000-4-29p DC Voltage Dips, Interruptions and Variations 27
   2.14 References 28
3. System Installation 29
   3.1 About This Chapter 29
   3.2 Hardware Installation 29
   3.3 PC Requirements 30
   3.4 PACS Unit 32
   3.5 Functional Test 33
   3.6 Front Panel Connections and Controls 40
   3.7 Rear Panel Connections and Controls 44
   3.8 Data Acquisition Card Installation - PCI Card Version 45
   3.9 Data Acquisition Card Installation – Legacy ISA Card Version 56
   3.10 CTS 3.0 Software Installation 61
   3.11 AC Source Control Software Installation 62
   3.12 Upgrading from a CTS 1.X or CTS 2.0 System 64
4. Program Menus 66
   4.1 About this Chapter 66
   4.2 Main Menus 66
   4.3 File Menu 66
   4.4 Edit Menu 67
   4.5 View Menu 68
   4.6 Options Menu 68
   4.7 Test Menu 69
5. Harmonics Testing 70
   5.1 About This Chapter 70
   5.2 Test Standard Selection 70
   5.3 Device Classes 70
   5.4 Stationary or Transitory Harmonics Test 73
   5.5 Running a Harmonics Test 74
   5.6 Additional Setup Parameters for Harmonics 76
   5.7 Main Harmonics Test Window Operation 78
   5.8 Running the Harmonics Test 81
   5.9 Printing Results 82
   5.10 Harmonics Test Data Files 82
   5.11 Three Phase Testing 82
   5.12 Replay Mode 83

6. Flicker Testing 85
6.1 About This Chapter 85
6.2 Principle of Operation 85
6.3 Flicker Test Options 85
6.4 Running a Flicker Test 87
6.5 Printing Results 91
6.6 Flicker Replay Mode 91
7. IEC 61000-4-11 Voltage Dips and Variations Immunity Testing 94
7.1 About This Chapter 94
7.2 Standard Revisions and EUT Classes 94
7.3 Compliance Statement 94
7.4 Specifying Test Sequences for Dips and Variations 95
7.5 Test Setup 98
7.6 Test Options 99
7.7 Test Results 99
7.8 Report Format- 411 Test Files 100
8. IEC 61000-4-13 Harmonics and Interharmonics Immunity Test 101
8.1 About this Chapter 101
8.2 Tab Controls 102
8.3 Test Setup 102
8.4 Test Sequence 104
8.5 Test Results 107
8.6 Measurements 108
8.7 IEC 61000-4-13 Test Reports 108
9. IEC 61000-4-14 Voltage Fluctuations Immunity Testing 109
9.1 About This Chapter 109
9.2 Test Setup 110
9.3 Test Options 110
9.4 Test Sequence 111
9.5 Test Levels 112
9.6 Voltage Fluctuation 113
9.7 Test Execution 114
9.8 Test Parameter File Creation and Limits 114
9.9 Test Results 114
9.10 Report Format- 414 Test Files 115
10. IEC 61000-4-17 DC Ripple Immunity Testing 116
10.1 About This Chapter 116
10.2 Test Setup 117
10.3 Test Sequence 117
10.4 Waveform Display 118
10.5 Test Results 118
10.6 User Observations 119
10.7 Report Format- 417 Test Files 119
10.8 Saving and Loading Test Setups 119
11. IEC 61000-4-27p Voltage Unbalance Immunity Testing 120
11.1 About This Chapter 120
11.2 Test Setup 122
11.3 Equipment Classifications 123
11.4 Test Levels 124
11.5 Waveform Display Tab 124
11.6 Operator Observations Tab 124
11.7 Source Regulation 125
11.8 Test execution 125
11.9 Test Implementation and Test Sequence 125
11.10 Test Reports 126

12. IEC 61000-4-28 Frequency Variations Immunity Testing 127
12.1 About This Chapter 127
12.2 Test Setup 128
12.3 Test Sequence 129
12.4 Test Levels 130
12.5 Test Options 130
12.6 Test Results 130
12.7 Test Reports 131
13. IEC 61000-4-29p DC Dips and Interruptions Immunity Test (Pre-compliance) 132
13.1 Test Setup 133
13.2 Setting nominal values 134
13.3 Test sequence 134
13.4 Test Options 136
13.5 Test Execution 136
13.6 Test Results 136
13.7 IEC 61000-4-29 Test Reports 137
13.8 Source Requirements 138
14. Customizing IEC 61000-4 Test Parameters 139
14.1 About This Chapter 139
14.2 IEC 61000-4-11 Implementations 139
14.3 Sample File IEC411.411 141
14.4 Sample File IEC413.413 142
15. Specifications 143
15.1 About This Chapter 143
15.2 Measurement System Specifications 143
15.3 PACS Specification 145
15.4 Environmental 146
15.5 Regulatory 146
15.6 Flicker Reference Impedance 147
16. Configuration Options 149
16.1 About this Chapter 149
16.2 Accessing the Calibration and Configuration Database 149
17. Calibration 152
17.1 About This Chapter 152
17.2 Calibration 152
17.3 Install A/D Card in PC 153
17.4 PACS-x Calibration Setup 153
17.5 Configuration Procedure 154
17.6 Installing New CTS 3.0 Calibration Data 157
18. Principle Of Operation 158
18.1 General 158
18.2 AC Power 158
18.3 PACS1 or PACS3 Measurement Unit 158
18.4 CTS 3.0 Software 158
19. Service 160
19.1 Cleaning 160
19.2 General 160
19.3 Basic Operation 160
19.4 Advanced Troubleshooting 163
Index 165

List of Tables

Table 1-1: CTS AC Source Models 13
Table 2-1: IEC 61000-3-2 Class Limits 19
Table 2-2: Harmonics Amendment 14 Test Times 20
Table 2-3: IEC 61000-3-2 Class Descriptions 22
Table 2-4: Average public utility disturbances per annum in Europe 25
Table 3-1: PC Pentium/Athlon Processor Clock Speed Requirement 31
Table 3-2: Reserved PC I/O Address Locations 58
Table 5-1 : IEC Harmonics Setup Parameters 75
Table 5-2 : IEC Harmonics Advanced Setup Parameters 77
Table 5-3 : IEC Harmonics Replay Settings 84
Table 6-1 : IEC Flicker Replay Settings 93
Table 15-1 PACS Specifications 145
Table 17-1: Required Calibration Equipment 152

List of Figures

Figure 3-1: EUT Connection distance and wire gauge..... 32
Figure 3-2: Functional Test Setup 34
Figure 3-3: Single-phase configuration 5001iX-CTS..... 35
Figure 3-4: Single-phase configuration 1251RP-CTS..... 36
Figure 3-5: Power Connections for PACS-1 for a single-phase CTS..... 37
Figure 3-6: Three-phase configuration 15003iX-CTS 38
Figure 3-7: Power Connections for PACS-3 in a three-phase CTS. 39
Figure 3-8: Switch Settings for Remote Impedance Control (Factory Default) 41
Figure 3-9: Switch Settings for Manual Impedance Control..... 41
Figure 3-10: Front and Rear Panel Views of the PACS-1 Module. 42
Figure 3-11: Front and Rear Panel Views of the PACS-3 Module. 43
Figure 3-12: Exacq Control Center Screen. 48
Figure 3-13: Exacq Card Device Number..... 49
Figure 3-14: Exacq Test Panel 50
Figure 3-15: Exacq DMM Screen 51
Figure 3-16: Exacq Scope Test Panel..... 52
Figure 3-17: NI E Series Explorer Panel 53
Figure 3-18: Figure 3 18: NI M Series Explorer Panel..... 53
Figure 3-19: Jumper and DIP switch location on the A/D Card..... 56
Figure 3-20: A/D Card JMP 11 Settings 57
Figure 3-21: A/D Card JMP 13 Settings 57
Figure 3-22: A/D Card Base I/O Address DIP 59
Figure 5-1: Class D Current Wave Shape Template..... 71
Figure 5-2: EUT Class Determination Flowchart..... 72
Figure 5-3: Typical Class A test setup..... 74
Figure 5-4: Additonal Settings for Harmonics Test..... 76
Figure 5-5: Harmonics Test Window 78
Figure 6-1: Flicker Test Window..... 87
Figure 7-1: IEC 61000-4-11 Test Window..... 95
Figure 7-2: IEC 61000-4-11 Voltage Variation specification- Edition 1.0..... 96
Figure 7-3: IEC 61000-4-11 Voltage Variation specification- Edition 2.0..... 96
Figure 7-4: IEC 61000-4-11 Setup screen..... 98
Figure 8-1: IEC 61000-4-13 Test Window..... 101
Figure 8-2: IEC 61000-4-13 Flow Chart Class 1 and 2. 104
Figure 8-3: IEC 61000-4-13 Flow Chart Class 3. 105
Figure 9-1: IEC 61000-4-14 Test Window..... 109
Figure 9-2: IEC 61000-4-14 Test Sequence..... 111
Figure 10-1: IEC 61000-4-17 Test Window..... 116
Figure 10-2: IEC 61000-4-17 Waveform Acquisition Window..... 118
Figure 10-3: IEC 61000-4-17 User Observation Data Entry Window..... 119
Figure 11-1: IEC 61000-4-27 Test Window..... 120
Figure 12-1: IEC 61000-4-28 Test Window..... 127
Figure 12-2: IEC 61000-4-28 Test Sequence 129
Figure 13-1: IEC 61000-4-29 Test Window..... 132
Figure 17-1 : CTS 3.0 Calibration Program Main Screen..... 153
Figure 17-2: Single Phase Calibration Setup 155
Figure 17-3: Three Phase Calibration Setup..... 156
Figure 19-1: Location of AC Sensor Assy. 5004-700 in PACS-x 162

1. Introduction

1.1 Manual Organization

This manual describes the operation of the California Instruments Compliance Test System Software when used in conjunction with the CTS hardware. Its primary function is as a reference manual. If you have a question about a specific screen or how to perform a certain task, turn to the appropriate section of the manual. The manual is organized in accordance with the normal test procedure you would follow when testing for IEC compliance.

Some assumptions were made when producing this documentation. Specifically, it is assumed that you are familiar with the IEC 61000-3-2 and IEC 61000-3-3 standards and their requirements. Some background information on the IEC standards covered by the CTS system is included in chapter 2. This information is subject to change however as standards do change. We recommend you stay current with evolving test standards and regulations. Furthermore, it is also assumed that you are familiar with operating a personal computer under the Microsoft Windows™ environment.

The manual is organized as follows:

Chapter 1 describes the organization of the user manual and provides a brief overview of the CTS system components.

Chapter 2 provides an overview of the relevant IEC regulations and how compliance testing to these regulations is implemented in the CTS 3.0 Software.

Chapter 3 covers installation of the hardware and software components required to operate the CTS system. Proper installation of both hardware and software is essential. This chapter walks the user through the hardware setup and the software installation, process one step at a time.

Chapter 4 Overview of the program's menu structure

Chapter 5 covers IEC 61000-3-2 harmonics testing. This chapter provides step by step instructions on how to set up the correct test mode and perform the necessary steps to perform a quasi-stationary or transitory Harmonics test on the EUT.

Chapter 6 covers IEC 61000-3-3 Voltage fluctuations testing. This chapter provides step by step instructions on running a voltage fluctuation or flicker test.

Chapter 7 covers IEC 61000-4-11 Voltage Dips and Variations immunity testing.

Chapter 8 covers IEC 61000-4-13 standard Voltage Fluctuations immunity testing. [Draft version]

Chapter 9 covers IEC 61000-4-14 standard Voltage Fluctuations immunity testing.

Chapter 10 covers IEC 61000-4-17 standard DC Ripple immunity testing.

Chapter 11 covers IEC 61000-4-27p standard Voltage Unbalance immunity testing.

Chapter 12 covers IEC 61000-4-28 standard Frequency Variations immunity testing.

Chapter 13 covers IEC 61000-4-29p DC Voltage dips and Variations immunity testing.

Chapter 14 covers IEC 61000-4 customization to allow for future revisions of these standards and to accommodate different product categories.

Chapter 15 provides the technical specifications for the Power Analysis and Conditioning System (PACS) unit, which is a key component of the CTS system. For technical specifications on the AC source supplied with the CTS system, refer to the AC source manual provided.

Chapter 16 overview of available configuration options.

Chapter 17 overview of calibration procedures

Chapter 18 provides theory of operation information.

Chapter 19 provides service and troubleshooting procedures.

1.2 Compliance Test System Description

The California Instruments Compliance Test System is a complete IEC AC power test system that covers many of the IEC regulatory test standards involving AC and/or DC powered equipment.

To ensure maximum flexibility of both the hardware and the software required to create a turn-key system, the CTS system uses a modular structure consisting of the following components:

- Programmable AC power source. The AC source provides precise, isolated and low distortion AC power at the user specified frequency and voltage. The AC source also offers over current protection to avoid damaging a load that exhibits a failure. The AC source can either be a single-phase or three-phase unit. For some DC tests, iX Series based CTS systems also provide DC output.
- Power Analysis and Conditioning System unit. The PACS unit creates the electrical and mechanical interface between the AC source, the Equipment Under Test (EUT) and the PC based data acquisition system. It provides the necessary signal conditioning and isolation for the acquisition system.
- PC Based data acquisition system. The data acquisition system uses a fast Analog to Digital conversion card that plugs into an available card slot in the user's PC. The CTS 3.0 software controls all aspects of the A/D card and processes the data for IEC test purposes.
- CTS 3.0 Software. The CTS 3.0 software implements the harmonics and flicker IEC tests. In addition to the CTS 3.0 Software, the California Instruments CIGUI32 (Series I iX) or CIGuiSII (Series II iX) Windows program is used to control the AC and DC source used and to implement those IEC tests that run on the AC source, specifically the IEC 61000-4 immunity tests.

The AC source output is connected to the rear of the PACS unit. For single-phase applications the user only needs to connect the EUT to the IEC/77 connector located on the front panel of the PACS unit to set up his test hardware. For three phase applications the rear terminals are used. All user interactions with the CTS system are accomplished through the CTS 3.0 and CIGUI32 or CIGuiSII software. There are virtually no front panel controls required to operate the CTS system.

1.2.1 AC Source Models

The CTS system is supplied with different programmable AC power sources depending on the configuration. The following AC sources are supplied with each CTS system:

Table 1-1: CTS AC Source Models

Model	VA Power	AC Source	IEC 61000-4	PACS model
Single Phase Systems				
100-CTS	AC Line	none	-	PACS-1
1251RP-CTS	1250 VA	1251RP	-	PACS-1RP
3001iX-CTS	3000 VA	3001iX	√	PACS-1
5001iX-CTS (-400)	5000 VA	5001iX (-400)	√	PACS-1
10001iX-CTS (-400)	10000 VA	10001iX (-400) (See note below)	√	PACS-1-75
Three Phase Systems				
300-CTS-75	AC Line	none	-	PACS-3-75
15003iX-CTS (-400)	15000 VA	15003iX	√	PACS-3
30003iX-CTS (-400)	15000 VA	30003iX-400 (See note below)	√	PACS-3-75

If you plan to use the AC line and are using a PACS-1 or PACS-3 system, you can skip this paragraph as there is no AC source included with the system. If you are using any of the other CTS configurations, the AC source includes its own user manual. We recommend you familiarize yourself with the operation of the AC source and the included Windows Graphical User Interface (CIGUI32 or CIGuiSII) for it before you start using the CTS system.

Note: PACS-1 and PACS-3 based CTS systems are rated for a maximum current of 40 amps rms per phase. Higher current versions, PACS-1-75 and PACS-3-75, are available. Existing 10001iX-CTS and 30003iX-CTS systems may not have been shipped with these -75 model versions however. Damage to the standard PACS units can occur if higher currents are present. Care must be taken to not exceed this rating when using the system directly with the utility line or with the higher power sources. When using a 10001iX-CTS or 30003iX-CTS system, the lower voltage/higher current output range should not be used unless the AC source's current limit has been set to 40 amps or less or the system was supplied with the -75 version of the PACS.

1.2.2 PACS Unit

The Power Analysis and Conditioning System provides the required electrical and mechanical interface between the AC source, the user's equipment under test and the data acquisition PC system. This allows all signal connections to be made easily and conveniently. The PACS can be single phase or three phase, depending on the CTS system configuration in use. Single phase PACS units may also contain the required reference impedance for making flicker measurements when a power source without programmable impedance is used. PACS units with the reference impedance built-in have a Bypass and Flicker mode that is controlled through the A/D card digital I/O from the CTS 3.0 software. The front panel controls for Bypass and Flicker mode are disabled. The mode of operation (Bypass for harmonics measurements and Flicker for flicker measurements) is indicated with a set of LED's.

The PACS unit has several AC power input and output connections as well as an interface connector to the PC based data acquisition system.

For higher power systems, the CTS system can be configured with the 75 A per phase versions of the PACS unit. (Standard on 30003iX-CTS system).

1.2.3 PC Based Data Acquisition System (updated for new PCI data acquisition)

All measurements required for IEC testing are performed by the data acquisition system that resides on the user's PC. The measurement card needs to be installed in an available slot and the software needs to be installed. All signal connections between the PC and the PACS unit are made with a single 37-pin cable supplied with the system.

The following data acquisition cards are supported by the CTS 3.0 software:

CI400PCI	PCI card	NI 6032/4E. No longer provided on new system shipments but still supported by CTS30 software revision 3.2.X
CI401PCI	PCI card	Exacq Technologies CM2110 PCI A/D card, 250 Ks/sec for single phase systems (P/N 250803)
CI403PCI	PCI card	Exacq Technologies CM2210 PCI A/D card, 1 Ms/sec for three phase systems (P/N 250797)

All CTS systems are delivered with a PCI bus A/D card. Older systems may use the –ISA or -MC cards. The CTS 3.0 software installation differs for each of these legacy A/D cards. For new installations, only the PCI card should be used however.

The data acquisition system samples all voltage and current channels at a high sampling rate and provides the data to the CTS 3.0 software for further processing. The PACS provides a single voltage input channel and three current input channels for each phase, to the PC. This allows for current range changing on the fly. There is no need for the user to select a current range as the software automatically uses the most suitable range available for the current signal.

1.2.4 CTS 3.0 Software Functions

The CTS 3.0 software application supports IEC 61000-3-2 and IEC 61000-3-3 compliance testing requirements using an intuitive graphical user-interface from which you can:

- Set up and run compliance-level tests. The setting up of many IEC details is facilitated through the use of embedded standards expertise.
- Collect real-time test data from the CTS System.
- Display and monitor real-time test results.
- Save test results to disk for analysis using other programs.
- Replay previously recorded test data and single step through the data frame by frame.
- Print reports and graphs in MS Word™ formats.

1.2.5 AC Source GUI Functions

If the CTS system in use was supplied with an AC source, it also includes an AC source control software package. This Graphical User Interface program can be used to control the AC source from the same PC using either the RS232C or IEEE-488 interface. An IEEE-488 interface is not included with the CTS system. The PC must have an available RS232C port to use the RS232C control interface to the source.

In the absence of a suitable interface, the user can operate the AC source from the front panel. This does not affect the ability to run harmonics and flicker tests. It does however preclude the use of the IEC 61000-4 immunity tests, which are only available through the CIGUI32[1] or CIGuiSII AC source control program.

[1] IEC 61000-4 tests are pre-compliance only on the 1251-CTS.

Note on Interface conflicts:

If the CIGUI32 or CIGuiSII program is set up to use the same serial or IEEE-488 port (any address) to communicate with the AC source as the CTS 3.0 software, it is not possible to have both the CTS 3.0 Software and the CIGUI32 or CIGuiSII software running at the same time. This is due to the fact that both programs would attempt to use the same interface to control the AC source. If this is the case, close one program before opening the other.

If IEEE-488 is used to control the AC source with the CIGUI32 or CIGuiSII and RS232C is selected on the CTS 3.0 or vice versa, both programs can be open at the same time but care should be taken not to control the source from both programs at the same time. This setup is not recommended however.

For best results, use either program in turn depending on the task at hand (CTS 3.0 for IEC 61000-3 and CIGUI32 or CIGuiSII for IEC 61000-4)

2. IEC Testing

2.1 About This Chapter

This chapter provides some background information on the various IEC test standards that apply to AC powered products. It also reviews some of the test equipment requirements that are important when testing for IEC compliance. Note that this information is subject to change as IEC standards change over time. This overview is by no means comprehensive and is only provided for reference. If the reader is not familiar with IEC test requirements for AC powered products, we strongly recommend consulting information on this subject that is available through other sources. References are provided at the end of this chapter.

The standards covered in this chapter include those, which the CTS system is capable of testing, specifically:

- IEC 61000-3-2 Quasi Static and Transitory Harmonics
- IEC 61000-3-3 Flicker
- IEC 61000-4-11 Voltage Dips and Variations (requires option -411 and EOS1 or EOS3)
- IEC 61000-4-13 Interharmonics and Harmonics Immunity Test [Draft standard] (requires option -413)
- IEC 61000-4-14 Voltage Fluctuations
- IEC 61000-4-17 DC Ripple
- IEC 61000-4-27p AC Voltage Unbalance (pre-compliance)
- IEC 61000-4-28 Frequency Variations
- IEC 61000-4-29p DC Voltage Dips and Variations (pre-compliance)

2.2 The EMC Directive

As the world population grows and the overall energy consumption increases, industrialized nations have become increasingly concerned with the future availability of energy. Reducing energy consumption by using more energy efficient lighting and motor drive systems is one approach being taken by European, US and Japanese governments. The need of more efficient electrical systems however typically requires the use of sophisticated semi-conductor based electronic circuits that produce current harmonics. This in turn effects power quality which is an increasing problem on public utility networks. As lighting systems with electronic ballasts and equipment with switching power supplies such as computers, TV’s, fax machines and printers proliferate, power quality deteriorates. The same is true for PWM controller motor drives. The International Electrical Committee (IEC) has released standards dealing with the low frequency public supply system. Initial standards were 555.2 (Harmonics) and 555.3 (Flicker) which have since been refined and are now available as IEC 61000-3-2 and IEC 61000-3-3 respectively. Effective January 1, 1996, most electrical devices sold within the member countries of the European Union (EU) must meet these standards as governed by the EMC directive.

2.2.1 Why do you have to test?

In general, these IEC directives do not have the legal force of law. However, the European Union (EU) has issued Euro Norms in the context of these IEC directives that are legally binding and are enforced by the EMC Police. The relevant enforceable standards are IEC 61000-3-2 and IEC 61000-3-3, which supersede EN60555.2 and EN60555.3 respectively. These standards are also known under the IEC designator IEC 61000-3-2 and IEC 61000-3-3. Recently, the universal IEC 61000 convention has been adopted for all IEC standards.

Individual member countries have issued identical national norms, either in their native language or in English, which carry the same legal enforceability. Other countries such as Japan and the USA are in the process of adopting similar standards. Penalties for violating these norms range from hefty fines to jail time. In cases where the manufacturer is not located in the EU, his distributor or authorized agent will be held liable. Local customs agencies can stop equipment that does not meet these IEC norms at the border. Compliance testing of equipment is performed by accredited laboratories run by European government agencies assigned with enforcing these norms. Also, competing vendors have been known to submit failing test results on competitors' products to local governments to force prosecution and gain a competitive advantage in the market place.

Conformance to the EMC low voltage directive is indicated by the CE mark. Note however, that the CE mark includes **MORE** than just IEC 61000-3-2 and IEC 61000-3-3.

2.3 The IEC 61000-3-2:2000 Standard

This standard is often referred to as Amendment 14. It is less stringent for class C and D products compared to the 1998 standard. Effective January 2001, products may be evaluated against this standard.

2.3.1 Test Classes

CENELEC-A14 changes the definition of Class-D products. Per the amendment, only TV's, PC's and PC monitors are to be tested per Class-D limits. This means that many products migrate to Class-A. Note that there is no change in classification for Class-A, B, and C products, but the harmonic analysis method for products with fluctuating power is affected by A-14 for these products as well.

The limits for Class-C & D are proportional. Whereas this doesn't cause any difficulties for products with a constant current/power level, the situation was less clear for products with fluctuating load levels. Most test systems implemented so-called dynamic limits, with the limits constantly being adjusted per the measured power (or the fundamental current for Class-C) while others used some average power level to set the limits. The latter systems determine this average power/current using some arbitrary method, and pre-test period. Thus different test systems implement different limits for the same (fluctuating power) products, which can result in one system PASSING a product while the other REJECTS it.

A second issue for fluctuating loads is the way the existing standard (1998 edition) defines criteria for passing and failing the harmonics test. The existing standard permits the unit under test to occasionally exceed the 100 % limit, provided the harmonics never exceed 150 % of the limit. In fact, the unit under test is allowed to exceed the 100 % level for 10 % of the test time. The test time for fluctuating loads is to be at least 2.5 minutes, i.e. the harmonics can exceed the 100 % limit for 15 seconds in every 150-second (2.5 min) period. For longer test times, one can perform this test in 2.5 minutes "time blocks" but another interpretation is to just take 10 % of the overall test time. Thus, the testing method for fluctuating loads was somewhat subject to interpretation by the test equipment manufacturer.

Pass/Fail criteria under the new standard are as follows:

> *The average value for the individual harmonic currents, taken over the entire test observation period shall be less than or equal to the applicable limits.*
>
> *For each harmonic order, all 1,5 s smoothed r.m.s. harmonic current values shall be less than or equal to 150% of the applicable limits.*
>
> *Harmonic currents less than 0,6% of the input current measured under the test conditions, or less than 5 mA, whichever is greater, are disregarded.*
>
> *For the 21st and higher odd order harmonics, the average values obtained for each individual odd harmonic over the full observation period, calculated from the 1,5 s smoothed values may exceed the applicable limits by 50% provided that the following conditions are met:*
>
> - *The measured partial odd harmonic current does not exceed the partial odd harmonic current, which can be calculated from the applicable limits.*
> - *All 1,5 s smoothed individual harmonic current values shall be less than or equal to 150% of the applicable limits.*

2.3.2 IEC 61000-3-2 Test Limits

The following table summarizes the current harmonic limits for each device class that are presently in effect. The limits are generally built into IEC test software programs such as California Instruments' CTS 3.0 Test System software. If the power level of a class D device drops below 75 W (configurable - see System Administrator Manual P/N 5004-985), no harmonic current limits are applied and the result will always show a pass.

Table 2-1: IEC 61000-3-2 Class Limits

Harmonic no. (n)	Class A	Class B	Class C	Class D	IEC 555-2
	A RMS	A RMS	% of fundamental RMS current	mA/Watt of input power (75 - 600 W)	A RMS TV Receivers > 165 W
2	1.080	1.620	2	-	0.300
3	2.300	3.450	30 x PF	3.400	0.800
4	0.430	0.645	-	-	0.150
5	1.140	1.710	10	1.900	0.600
6	0.300	0.450	-	-	-
7	0.770	1.155	7	1.000	0.450
8	0.230	0.345	-	-	-
9	0.400	0.600	5	0.500	0.300
10	0.184	0.276	-	-	-
11	0.330	0.495	3	0.350	0.170
12	0.153	0.230	-	-	-
13	0.210	0.315	3	0.296	0.120
Even 14-40	1.84 / n	2.760 / n	-	-	-
Odd 15-39	2.25 / n	3.338 / n	3	3.850 / n	1.500 / n

The actual class limits for all classes have not changed with amendment 14. The power levels for Class D on which these limits are calculated however and the fundament current and power factor for class C have been changed however.

First of all, the manufacturer is required to declare the rated power (the fundamental current and Power Factor for Class-C) for the product. This “rated power” (current & PF) will be used as the basis for the limit calculation of Class-D (Class-C). Thus, a “rated power” of 150 Watt for example, will yield a third harmonic limit of 150 x 3.4 = 510 mA. Similarly, a rated fundamental current of 0.4 Amp, and a rated PF of 0.98 for an electronic ballast will result in a third harmonic limit of 0.4 x 0.3 x 0.98 = 117.6 mA. Thus, the amendment requires that an automated compliance test system must allow the user to enter this rated power or rated current. Also, the test system must verify the power (fundamental current and PF) because these “rated vales” as declared by the manufacturer must be within +/- 10 % of the actual values. If not, the actually measured values are to be used for the limit calculation. The method to measure these actual power, fundamental current and PF differ from the “average method” used in existing test systems, and of course differ also from the “dynamic limit method”.

The Pass/Fail criterion is given above. The “10 % of the time over 100 % of the limits” no longer exists. The average harmonic level during the whole test must simply be below the limit, and individual values in each acquisition window (after 1.5 sec filtering) must be below 150 % of the limit. There is also an extra allowance for the higher harmonics from H_{21} - H_{39}.

The CTS fully supports and implements Amendment 14.

2.3.3 IEC 61000-3-2:2000 Test Time

Under the new test standard, four test times (observation periods) are allowed depending on the nature of the EUT. All are aimed at ensuring repeatability of test results when tests are performed under the same conditions and on the same test system. Repeatability for this purpose is defined as results that are within 5 %. Available observation periods shown in the table below.

Table 2-2: Harmonics Amendment 14 Test Times

Type of equipment behavior	**Observation period**
Quasi-stationary	T_{obs} of sufficient duration to meet the requirements for repeatability.
Short cycles (Tcycle < 2.5 min)	T_{obs} > 10 cycles (reference method) or Tobs of sufficient duration or synchronization to meet the requirements for repeatability. 'Synchronization' means that the total observation period is sufficiently close to including an exact integral number of equipment cycles such that the requirements for repeatability are met.
Random	T_{obs} of sufficient duration to meet the requirements for repeatability.
Long cyclic (Tcycle > 2.5 min)	Full equipment program cycle (reference method) or a representative 2.5-min period considered by the manufacturer as the operating period with the highest total harmonic content.

2.4 The IEC 61000-3-2 Ed 2.2:2004 Standard

This section covers the 2004 standard which incorporates amendments 1 and 2 and amendment 14. This standard must be to test products since January 2004..

The purpose of enforcing the IEC 61000-3-2 standard is to limit the amount of current harmonics produced by electronic loads. Since harmonic currents caused by a load in turn produce voltage harmonics across the public utilities impedance, they affect other equipment connected to the same circuit. In fact, most public utilities exhibit voltage distortion caused by non-linear loads. Because harmonics can have serious effects on many electrical devices, efforts to set standards to limit their presence date back to the 1930's. This resulted in the IEC's Technical Committee (TC) setting standards dealing with current harmonics as far back as 1977. These standards became the basis for IEC standards 1000-3-2 and 1000-3-3 adopted in 1993. Because of their long history, many people still refer to these standards as 555.2 and 555.3 although there are some differences between the older and newer versions and tests performed today should be done according to the new standards, not the old ones.

Another confusing issue that is rooted in history is the nature of the products that fall under these IEC norms. While the original 555 specifications focused primarily on consumer products and excluded many professional and industrial products, the new IEC 1000-3 norms expanded coverage to include all electrical products with a rated input current up to 16 A rms per phase. Presently, only products with a line input voltage of 220 V and above are included. Japan and the US are working towards similar requirements that would cover products that require 100 Volts and up. Due to the original scope of the IEC 555 norms, many manufacturers are still under the impression that their products are exempt since they are not considered consumer products. Especially manufacturers of switching power supplies - some of the worst "offenders" when it comes to generating harmonics currents - have been caught off guard.

2.4.1 Test Classes

The standard divides products to be tested in to four classes, A, B, C and D. Each class has its own harmonic current limits. Class A is the default class, meaning if a product does not fall into the categories for class B, C or D, it is by default class A. The product classes are defined as follows:

Table 2-3: IEC 61000-3-2 Class Descriptions

Class	Description
A	All motor driven equipment, most “domestic” appliances and virtually all 3 phase equipment (<16 A rms per phase)
B	All portable electric tools
C	All lighting products, including dimmers, with an active input power above 25 Watts.
D	Products having a power range from 75 to 600 Watts AND a current waveform that has a special wave shape.

Test limits are most stringent for Class-C and Class-D equipment. These classes were established to cover the wide range of products that uses “cheap” switching power supplies with a rectifier capacitor input. These units typically exhibit relatively high odd harmonics. Since this type of supply is so commonly used, the effect of a large quantity of products like this can add up to significant problems. To limit this effect, the current harmonic limits for class-D equipment are specified in mA/W instead of an absolute current value as is done for class A and B. Many consumer and professional devices such as TV’s, VCR’s, stereos, PC’s, fax machines, printers etc. may fall into the more stringent class D category.

Class-C limits are not specified in absolute values either but rather as a percentage of the fundamental current. The third harmonic limit is also a function of the power factor so is harder to meet as the power factor decreases. Neither class C nor D devices have to meet even current harmonics limits.

Since class C and D limits are load dependent, the power level and power factor have to be determined for each test. In case of fluctuating power levels, it may be necessary to measure the power level during the test and adjust the limits used to pass or fail the unit under test dynamically.

This dynamic nature of the class C and D limits has resulting in some confusion and a possible problem of inconsistent test results when using IEC test systems for different vendors. The Standards body working group for harmonics is in the process of clarifying some of the class and limit issues and these efforts are likely to result in a revision of classes and limit calculations sometime in the year 2001. Until a new standard is established, the CTS 3.0 software maintains a database of test limit values than can be updated over time if needed without changing the core program.

CTS 3.0 software makes dynamic classification for Classes A and D. The classification follows the following principle. If during either a Class A or D test the EUT becomes a Class A device, the EUT will be considered a Class A device. If the EUT is a Class D device through out the test, then the device is a Class D device. In other words, Class A is a latching classification. Please note that even though the classification may change during a test, a Class A (or D) test will still be performed according to Class A (or D) specification.

2.4.2 Steady State versus Transitory Harmonics

Two types of harmonics testing are called for in the IEC 61000-3-2:1998 standard, a quasi steady state and a transitory one. The transitory harmonics tests allow for equipment that has power demands that vary over time to temporarily exceed the harmonic current limits by as much as 50 %, as long as such elevated levels do not occur for more than 10 % of the test period. Since the minimum test time required is 2.5 minutes or 150 seconds, this means the current harmonics can be as high as 150% of the standard limits for no more than 15 seconds in any 150 second period. This requirement imposes more demands on the power analyzer being used than it does on the AC power source.

Steady state harmonics are those exhibited by equipment that has a constant current draw such as a fluorescent lighting fixture. Many pieces of equipment, such as Laser printers that have a heating element that kicks in any time a page is printed, have fluctuating power demands and may require transitory harmonics testing.

Note that Amendment 14 does away with the distinction between stationary and transitory harmonics.

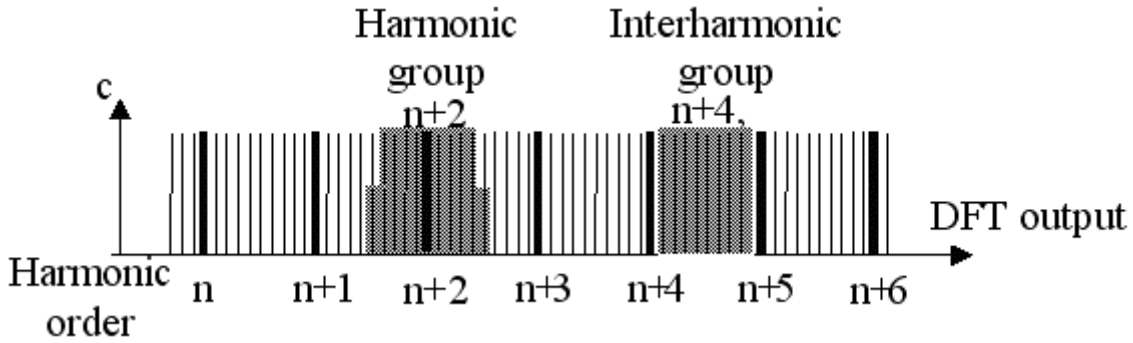
2.4.3 IEC 61000-4-7 Inter Harmonics Evaluation.

IEC61000-3-2 Edition 2.2 (2004-11) references measurement methods per IEC61000-4-7 and Edition 2.0 of this measurement standard specifies the inclusion of inter harmonics. For the assessment of harmonics, the harmonic and inter-harmonic current levels are grouped to be the sum of squared intermediate lines between two adjacent harmonics according to the equation below, as visualized also in the accompanying figure. The resulting harmonic group component of order n (corresponding to the center line in the hatched area) has the magnitude C (rms value).

$$C_{ng}^2 = \frac{C_{10ng-5}^2}{2} + \sum_{i=-4}^{4} C_{10ng+i}^2 + \frac{C_{10ng+5}^2}{2} \quad \{50\ \text{Hz system}\}$$

$$C_{ng}^2 = \frac{C_{12ng-6}^2}{2} + \sum_{i=-5}^{5} C_{12ng+i}^2 + \frac{C_{12ng+-}^2}{2} \quad \{60\ \text{Hz system}\}$$

In these equations, “c” is the modulus of the spectral component corresponding to an output bin of the Fourier Transform of the data obtained from the 200 ms acquisition period , and “C” is the resulting modulus of the harmonic which is to be compared against the limits in IEC61000-3-2 for the selected test class.



This inter harmonics measurement is not mandatory as of this writing, as the use of equipment meeting the previous version of IEC61000-4-7 (the older Edition 1) is permitted for a short period (until the existing IEC61000-4-7 Edition 2 has gone through its maintenance cycle). Therefore the user has the option to either disregard inter harmonics, or to group them into the assessment by selecting the appropriate field in the “Test Category” settings.

It should be noted that selecting this “inter harmonics grouping” has little impact on the measurement results for the vast majority of products. Only products with active power factor correction AND highly fluctuating power consumption will produce inter harmonic levels that would add to the level of “C” as given above. Most products do not produce inter harmonics, and therefore the measured harmonic currents will be the same either way.

2.5 The IEC 61000-3-2 Ed 3.0:2005 Standard

The newer standard allows Class A test to exceed 150% limit and less than or equal to 200% of the applicable limits under the following conditions, which apply all together:

1) The EUT belongs to Class A for harmonics.
2) The excursion beyond 150% of the applicable limits lasts less then 10% of the test observation period or in total 10 min (within the test observation period), whichever is smaller, and
3) The average value of the harmonic current, taken over the entire test observation period, is less than 90% of the applicable limits.

2.6 IEC 61000-3-3 Flicker

Flicker standards are imposed to limit voltage variations caused by loads connected to the low voltage supply network that would cause lights connected to the same circuit to flicker. A complex measurement approach outlined in IEC 868, was devised to correlate voltage fluctuations to a human perceptibility factor (P). The IEC 61000-3-3 standard sets limits for voltage fluctuations caused by electrical apparatus with a current level up to 16 Amps per phase. The standard describes a human flicker perceptibility curve that defines the upper limit for acceptable flicker. This curve plots the percentage of voltage fluctuation against the amount of voltage fluctuations per minute.

As is the case for the Harmonics standards, the Flicker standard dates back several years and was rooted in the IEC 555.3 specification. Today however, the IEC 61000-3-3 standard should be used to evaluate equipment. Note that low power equipment generally does not cause Flicker and therefore often can be exempted from this requirement. The standard permits the equipment manufacturer to prove via analysis that their products are unlikely to cause voltage fluctuations. This analysis becomes part of a Technical Construction File (TCF) which in turn may be used to obtain product certification.

2.6.1 IEC 61000-3-3 Flicker Test AC Source Requirements

As is the case with Harmonics testing, the IEC 61000-3-3 standard imposes requirements on the AC source that is used. Some of these requirements are similar and less severe than those imposed under IEC 61000-3-2. For example, total harmonic distortion of the voltage can be 3 % for Flicker testing as opposed to only 1.25% for harmonics testing. The voltage regulation needs to be better than 2 % which is not a problem for most AC sources. In rare cases, the line voltage may even be used for this purpose. More often than not, however, the use of an AC source with well-defined specifications is recommended to obtain repetitive test data and eliminate the possibility of flicker caused by line fluctuations, not load current fluctuations. California Instruments offers AC power sources in both single and three phase configurations that meet these requirements. The same AC power source described under IEC 61000-3-2 (Harmonics) AC source requirements can be used for Flicker test applications.

To simulate the resistance and inductance of the low voltage distribution systems, the IEC 61000-3-3 requires a specific AC source output impedance to be used. This reference impedance, as specified in IEC-725, is defined in such a way that it approximates a typical distribution network impedance. Individual countries may require the use of a different reference impedance that more closely resembles the actual impedance of that countries’ specific

distribution network. Most European countries use the specified reference impedance value however.

The required reference impedance for Flicker testing is either built into the PACS unit of the single phase CTS systems or provided through a programmable output impedance of the AC Source. This is determined by the AC Source model used. Optionally, a lumped reference impedance option is available for customers who prefer to use this approach over the programmable output impedance method.

Note that the lumped reference impedance option for the CTS system is exactly matched to the California Instruments' power source output impedance with which they are used. Do not use third party reference impedance networks with the CTS system as the combined AC source and network impedance may not match the IEC 61000-3-3 requirement. The 1251RP-CTS is always supplied with a lumped reference impedance built in to the PACS-1 unit as these AC Source models do not offer programmable output impedance.

In general, programmable output impedance of the AC Source yields higher accuracy compared to a physical lumped impedance. It also allows testing against other national flicker standards such as those in Japan where different reference impedance values are called out.

2.6.2 When to Test for IEC 61000-3-3

As mentioned, it may not be necessary to test every product for IEC 61000-3-3. If it can be shown that maximum power consumption of the unit under test is low, and the surge current level at turn-on is limited, it can be shown that the product causes insignificant Flicker levels across the reference impedance. For loads having an rms current draw of more than 5 Amps, it is generally recommended to verify conformance to IEC 61000-3-3 however.

2.7 IEC 61000-4-11 Voltage Dips and Variations

The IEC 61000-4-11 is an immunity test for low voltage equipment to ensure reliable operation when connected to the public distribution system. This test requires an AC source that is capable of generating specific voltage variations and voltage dips. The unit under test must not sustain any damage from such occurrences nor cause unsafe conditions.

Table 2-4: Average public utility disturbances per annum in Europe

DEPTH	DURATION			
(Voltage drop in % of nominal Ut)	10 to < 100 ms	100 to < 500 ms	500 ms to 1 sec	1 sec to > 3 sec
10 %o < 30 %	61	66	12	6
30 % < 60 %	8	36	4	1
60 % < 100 %	2	17	3	2
100 %	0	12	24	5
	Number of disturbances per year			

The need to test for immunity of products against voltage dips and interruptions was prompted by studies of electric utility availability. The results shown in Table 2-4 were found in this study (UNIPEDE study 91 en 50.02). From this data it is clear that most disruptions are short in nature (about 5 to 10 periods) and no more than 60 % below nominal. Occasionally however, extended periods of complete power loss occur. It is suggested that this test data also be used as a guide in selecting appropriate test levels.

2.7.1 Why Do You Have to Test?

The IEC 61000-4-11 affects a large set of products, specifically; *"Electrical and electronic equipment having a rated input current not exceeding 16 A per phase."* Thus, most single and three phase AC powered equipment used in domestic and light industrial settings fall in this category. In fact, around 95 % of all electrical equipment in household and light industrial applications, require no more than 16 A per phase. In Europe, this implies real apparent levels of 230 V * 16 A = 3680 VA, with real power either at the same or a lower level. Specifically excluded are all DC powered products (battery operated devices) and 400 Hz AC equipment. (Avionics) These products will be covered in future IEC standards. At this time meeting the IEC 61000-4-11 standard is required for most products to obtain the CE Mark, required to market products in the European Union.

California Instruments' CTS system supports IEC 61000-4-11 testing using an iX Series AC power source. For full AC Source compliance, the EOS1 or EOS3 Electronic Output Switch option is required. Non iX Series based CTS systems offer pre-compliance testing of IEC 61000-4-11 only. The test sequencer and report generation for IEC 61000-4-11 is provided through the CIGUI32 or CIGuiSII Windows® software. To accommodate changes in the specification, test levels and duration can be set by the operator or loaded from disk if needed.

2.8 IEC 61000-4-13 Interharmonics and Harmonics Immunity Test

The IEC413 option is capable of performing IEC 61000-4 section 13 Harmonics and inter harmonics low frequency immunity tests. The tests are based on IEC 61000-4-13:2002-03, First Edition. It is assumed that the user has a copy of the test standard available. This manual section only cover operation of the –413 option from the front-panel of the iX Series power source.

Note 1: The initial release of the –413 option for the iX Series power sources was based on a draft version (CDV) of the IEC 61000-4-13 standard. Minor changes were made between the CDV draft and the final released version. Units with firmware revision 2.37 or higher conform to the official released IEC standard. Units with older firmware conform to the draft version. A firmware upgrade can be ordered through California Instruments' service department by contacting support@calinst.com and requesting part number CIC463. Provide the model and serial number of the unit (master unit in multi-box systems) to ensure the correct firmware is provided. The firmware revision is displayed on the LCD screen immediately after power up for a few seconds. It can also be queried over the bus using the "*IDN?" command.

Where relevant, the requirement for the correct firmware revision to obtain specific test modes is indicated in this manual.

Note 2: The –413 option is only available on iX Series AC power sources, not i Series. It is possible to upgrade most i Series AC source to an iX Series and add the –413 option. Contact the California Instruments service department for information. support@calinst.com

2.9 IEC 61000-4-14 Voltage Fluctuations

The IEC 61000-4-14 is aimed at testing a product for immunity against voltage fluctuations that can occur on the public utility. The nature of the voltage fluctuations is different from those tested under IEC 61000-4-11 however. The fluctuations covered in this standard are less severe and involve typical high and low line conditions.

California Instruments' CTS system supports full compliance IEC 61000-4-14 testing on all iX Series based CTS systems. The IEC 61000-4-14 test is implemented in the CIGUI32 or CIGuiSII Windows® software. To accommodate changes in the specification, test levels and duration can be changed by the operator or loaded from disk if needed. Non iX Series based CTS systems offer pre-compliance testing of IEC 61000-4-14 only.

2.10 IEC 61000-4-17 DC Ripple

The IEC 61000-4-17 is aimed at testing a DC powered product for immunity against voltage ripple. Ripple is often caused by feed-through from the AC input section of a DC supply and exhibits itself as a small AC signal riding on the DC output. The IEC 61000-4-17 standards covers test levels and frequencies for testing the immunity of DC products against such phenomena.

The CTS system supports full compliance IEC 61000-4-17 testing (iX Series based CTS systems only). The IEC 61000-4-17 test is implemented in the CIGUI32 or CIGuiSII Windows® software. To accommodate changes in the specification, test levels and duration can be changed by the operator or loaded from disk if needed. Non iX Series based CTS systems do not offer this test.

2.11 IEC 61000-4-27p Three Phase Voltage Unbalance

Three phase CTS systems support pre-compliance IEC 61000-4-27 testing. The IEC 61000-4-27 test is implemented in the CIGUI32 OR CIGUISII Windows® software. To accommodate changes in the specification, test levels and duration can be changed by the operator or loaded from disk if needed.

2.12 IEC 61000-4-28 Voltage Frequency Variations

The CTS system supports full compliance IEC 61000-4-28 testing (iX Series based CTS systems only). The IEC 61000-4-28 test is implemented in the CIGui32 OR CIGuiSII Windows® software. To accommodate changes in the specification, test levels and duration can be changed by the operator or loaded from disk if needed. Non iX Series based CTS systems offer pre-compliance testing of IEC 61000-4-28 only.

2.13 IEC 61000-4-29p DC Voltage Dips, Interruptions and Variations

The CTS system supports pre-compliance IEC 61000-4-29 testing (iX Series based CTS systems only). The IEC 61000-4-29 test is implemented in the CIGui32 or CIGuiSII Windows® software. To accommodate changes in the specification, test levels and duration can be changed by the operator or loaded from disk if needed. Non iX Series based CTS systems do not support testing to IEC 61000-4-29.

2.14 References

Additional information on IEC norms and requirements may be obtained from the following sources. You may also check for the latest IEC related information on California Instruments' web site at www.calinst.com.

Document Number	Date of Publ.	Title
IEC 725	(1981)	"Considerations on reference impedances for use in determining the disturbance characteristics of household appliances and similar electrical equipment."
IEC 868	(1986)	"Flicker meter, Functional and design specifications."
IEC 868 Amendment 1	(1990)	"Flicker meter, Functional and design specifications."
IEC 868-0	(1991)	"Part 0: Evaluation of flicker severity."
IEC 61000-3-2	(1995)	"Part 3: Limits - Section 2: Limits for harmonic current emissions (equipment input current $\leq$ 16 A per phase.)"
IEC 61000-3-3	(1994)	"Part 3: Limits - Section 3: Limitation of voltage fluctuations and flicker in low-voltage supply systems for equipment with rated current $\leq$ 16 A."
IEC 61000-4-7	1996	"General guide on harmonics & inter-harmonics" New version expect early 2002.

Copies of complete IEC standards
may be obtained from at:

International Electrotechnical Commission (IEC)
P.O. Box 131
1211 Geneva 20
Switzerland
Phone: +41 22 919 0300
Fax: +41 22 919 0228
Web: www.iec.ch

or in the USA:

American National Standards Institute (ANSI)
Sales Department
11 West 42nd Street
New York, NY 10036
Phone: +212 642 4900 Fax: +212 302 1286

3. System Installation

3.1 About This Chapter

This chapter provides information on system installation and covers both the hardware connections that need to be made between the various components and the software setup. Proper installation of all hardware components and software modules is required to successfully use the CTS system. Some experience with AC power systems and PC's running Windows is assumed.

3.2 Hardware Installation

3.2.1 Unpacking

Inspect the unit for any possible shipping damage immediately upon receipt. If damage is evident, notify the carrier. DO NOT return an instrument to the factory without prior approval. Do not destroy the packing container until the unit has been inspected for damage in shipment.

3.2.2 AC Source

Refer to the User Manual provided with the AC Source.

The main power requirements for the CTS are dictated by the AC power sources used and the power levels that the Equipment Under Test will demand. Consult the AC Power source manual for input current and input wiring requirements.

3.3 PC Requirements

The CTS system requires a PC to operate. The included CTS 3.0 software must be installed on a PC capable or acquiring and processing data in real-time to ensure no-gap acquisition as required by both the harmonics and flicker test standards.

NOTE: It is recommended to purchase the required PC from California Instruments using the CIC-PC-PCX option. This ensures a suitable PC with the software pre-installed and tested will be furnished with the system for turnkey operation. This option also includes a monitor and printer. If this option is not ordered, the PC to be used with the system should be shipped to California Instruments prior to delivery for integration and test. In this case, it is the customer's responsibility to ensure the provided PC meets the performance criteria outlined below.

The PC requirements will depend to some extend on the following factors:

- The phase mode. Three phase systems require more CPU power than single-phase systems.
- The type of A/D card used. Three phase systems based on the ISA are unable to process interharmonics.
- The version of Windows operating system used.
  From time to time, a newer version of the CTS 3.0 software may be released. New versions are tested only with contemporary operating systems. As such, it may be required to upgrade to a newer operating system to support the latest version of the CTS 3.0.XX software. Presently, CTS 3.0.XX is tested only on Windows XP and Windows Vista platforms.
- For report generation, a copy of MS Word is required. The MS Word version supported is Word 9.0 (Word 2000). Older versions of MS Word may no longer work when upgrading to the latest CTS 3.0.XX software version. In that case, a newer version of MS Word may have to be installed.

The matrix below shows the required minimum process clock rate. These clock rates apply to either Celeron, Pentium 4 or AMD Athlon and Klamath based PC's. The values shown are minimum values, not recommended values. To allow future expansion, it may be advisable to plan on using a faster PC.

Other minimum PC requirements are:

- Windows XP, Windows 2000 or Windows Vista. Other versions of Windows operating systems are no longer supported.
- RAM size 512 Mbytes minimum.
- SVGA (800 x 600 resolution, 16 or more colors).
- IDE or SCSI hard disk drive of 20 GByte size or more.

PC Processor speed matrix shown minimum clock speeds, not recommended clock speeds for the PC. A faster PC can be used. This assumes other applications and/or screen savers that take up processor time are generally closed.

Table 3-1: PC Pentium/Athlon Processor Clock Speed Requirement

Mode	A/D Card	Win XP / 2000
Single phase	PCI	2.6 GHz
Three phase	PCI	3.2 GHz

3.4 PACS Unit

The PACS measurement module can be operated on either 115V or 230 V. It requires less than 0.5 Amps to function.

3.4.1 Mechanical Installation

The PACS unit can be used free standing on a bench and may be placed on top of the AC power source. Rack handles are standard, and if the optional rack slides are ordered, then the entire CTS system may be mounted in a standard 19 inch cabinet. The units are fan cooled, drawing air in from the sides and exhausting at the rear. The sides of the unit must be kept clear of obstruction and a 6 inch (152 mm) clearance must be maintained to the rear for proper cooling.

3.4.2 EUT Connection Wiring

For single phase wiring diagrams see Figure 3-3, Figure 3-4 and Figure 3-5. For three phase systems, see Figure 3-6 and Figure 3-7. The wire size used is dictated by the measured currents and voltages. Any wire used must be rated for the maximum expected current and voltage. The PACS unit is rated for 40A RMS maximum per phase when the rear power terminals are used and therefore AWG 8 is recommended if currents >30A and up to 40A are expected. For currents in the 15 to 30A range AWG 10 is sufficient.

The PACS-3-75 used on 10001iX-CTS and 30003iX-CTS systems is rated for 75 A and as such requires the use of at least AWG 6 wire gauge or larger diameter.

Caution: It is important to keep the distance between the PACS output and the EUT as short as possible to avoid adding additional wiring impedance to the test setup.

This is particularly important for flicker test measurements, as the wire impedance will affect the level of any voltage fluctuations caused by the EUT. Try to limit any output wiring to no more than 5 feet (1.5 meters) or use larger diameter wire as the distance to the EUT increases. Refer to Figure 3-1.

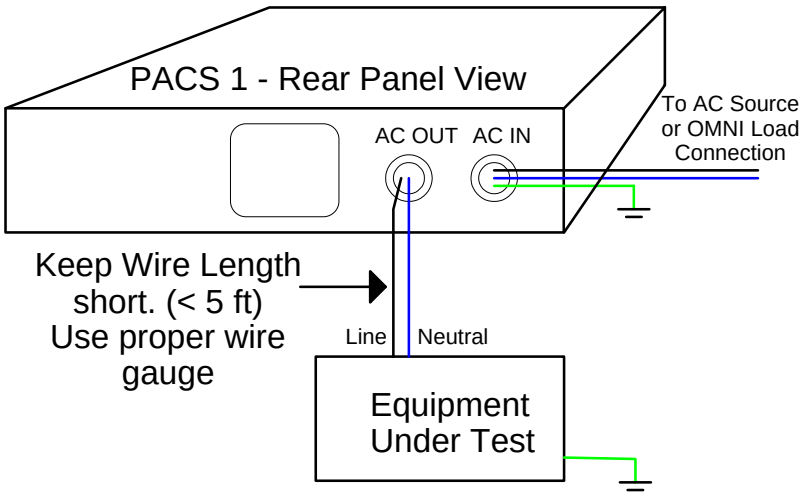


Figure 3-1: EUT Connection distance and wire gauge.

In addition, when doing compliance testing from the front panel outlet on a single phase PACS unit, bear in mind the rating of the IEC/77 outlet socket is 16A RMS max.

***Caution*: Be sure to replace the small rear top cover on the PACS unit after the wiring has been installed, otherwise insufficient cooling of internal components may result.**

3.5 Functional Test

If it is desired to perform a functional test of the system upon receipt the following procedure can be used. However, the AD signal card and the CTS 3.0 Software must first be installed for proper operation. See installation instructions later in this section.

CAUTION: Work carefully when performing this test, hazardous voltages will be present on the AC input and output connections during this test.

Refer to Figure 3-2 for the test setup. See also Figure 3-3 through Figure 3-7 for detailed installation diagrams.

1. Connect a current transformer to the neutral wire going into the AC input port at TB4 on the rear of the PACS unit. Connect the CT output to a DMM to read the actual input current.
2. Connect a DMM to the line and neutral connections at TB4 inside the rear panel.
3. Connect a 10 Ω load to the front panel outlet, or, use the rear panel AC outlet port at TB3.
4. Enable the AC power input to the PACS unit, whether from the line or from a power source. Apply 120Volts AC at 60Hz.
5. Start the **CTS 3.0** software in harmonics mode and measure the load current and voltage from the GUI. Verify the GUI readings and the external DMM readings for current and voltage are within 1% of each other.

In the unlikely event the power source does not pass the functional test, refer to the calibration procedure in section 0, or, refer to the service procedure in Section 19. If the problem cannot be resolved, call California Instruments' customer satisfaction department for further assistance.

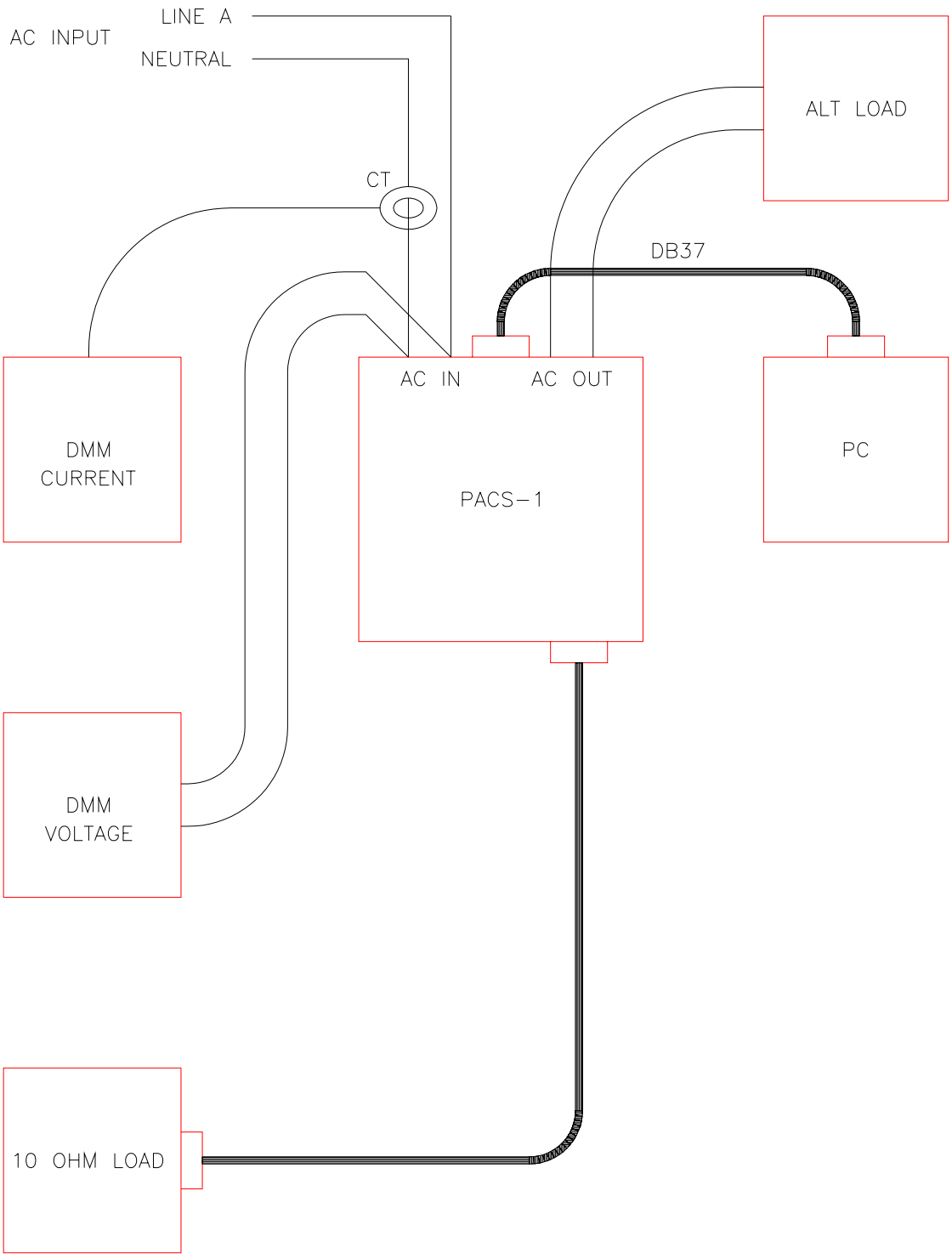


Figure 3-2: Functional Test Setup

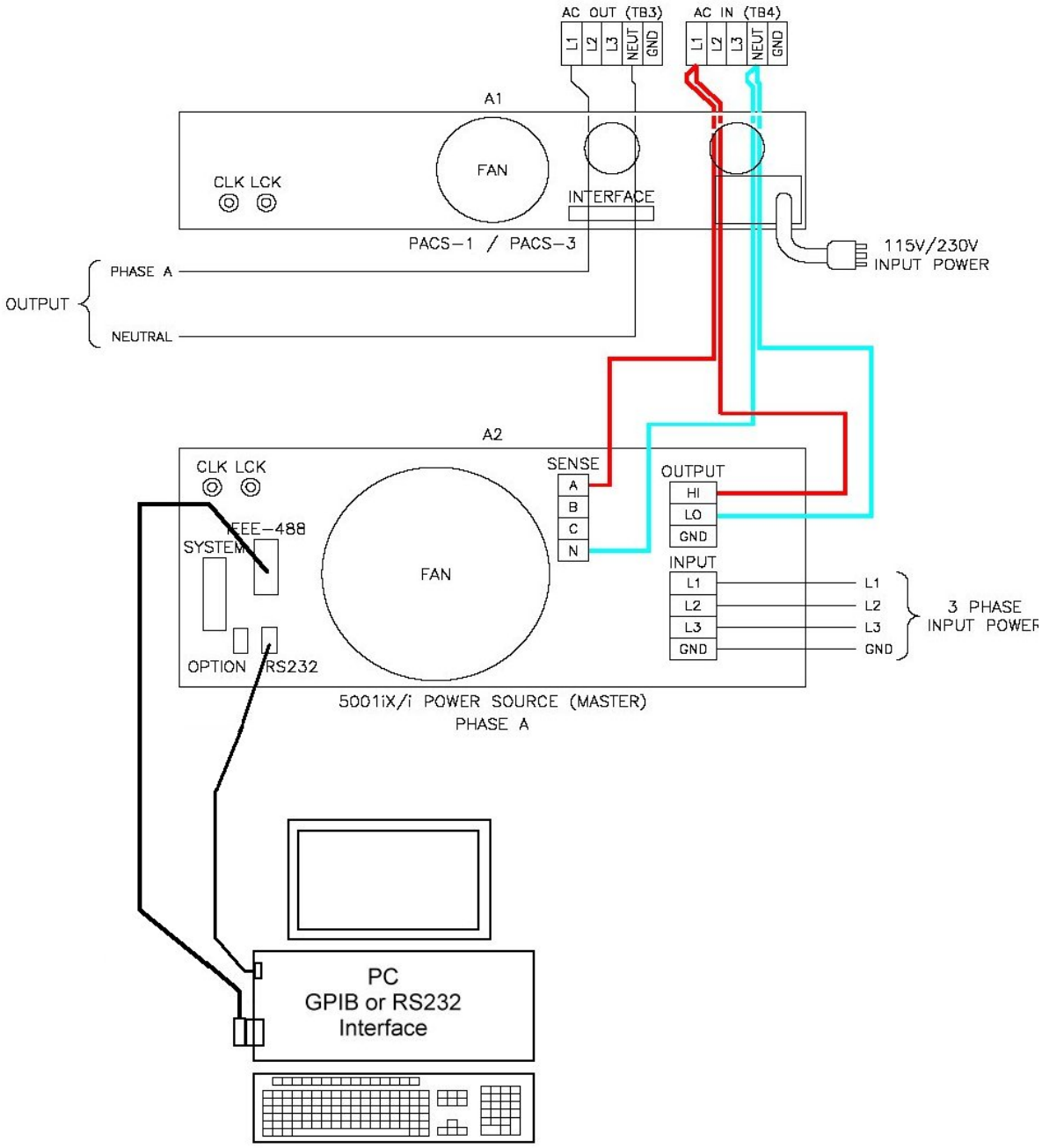


Figure 3-3: Single-phase configuration 5001iX-CTS

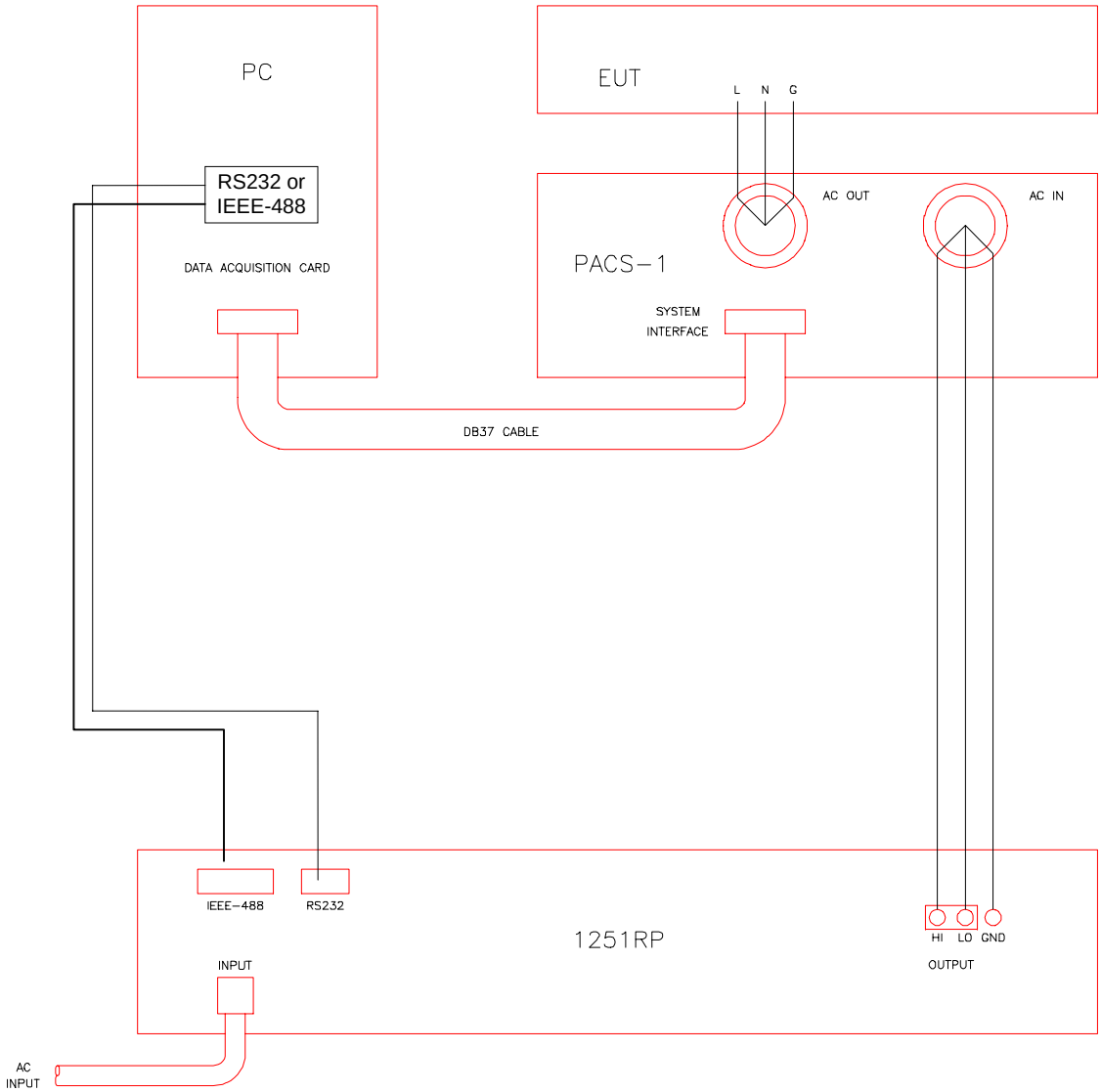


Figure 3-4: Single-phase configuration 1251RP-CTS

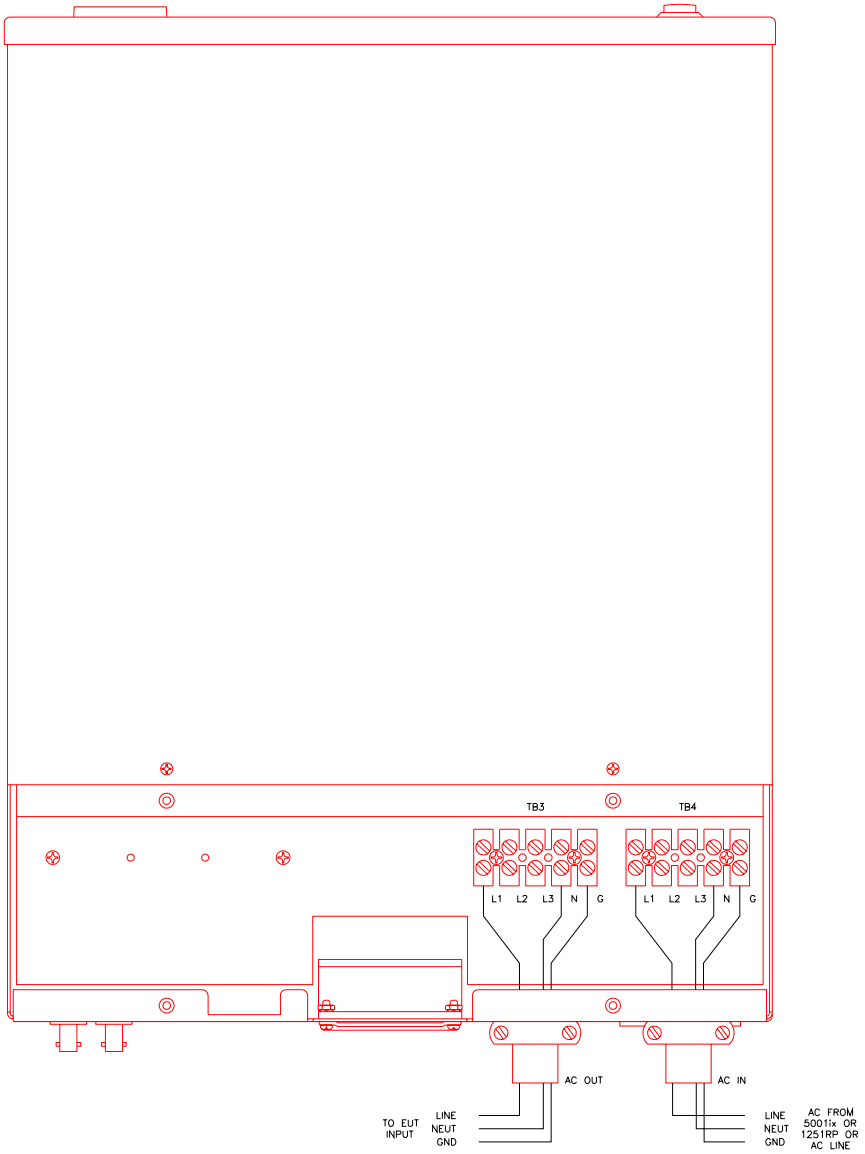


Figure 3-5: Power Connections for PACS-1 for a single-phase CTS.

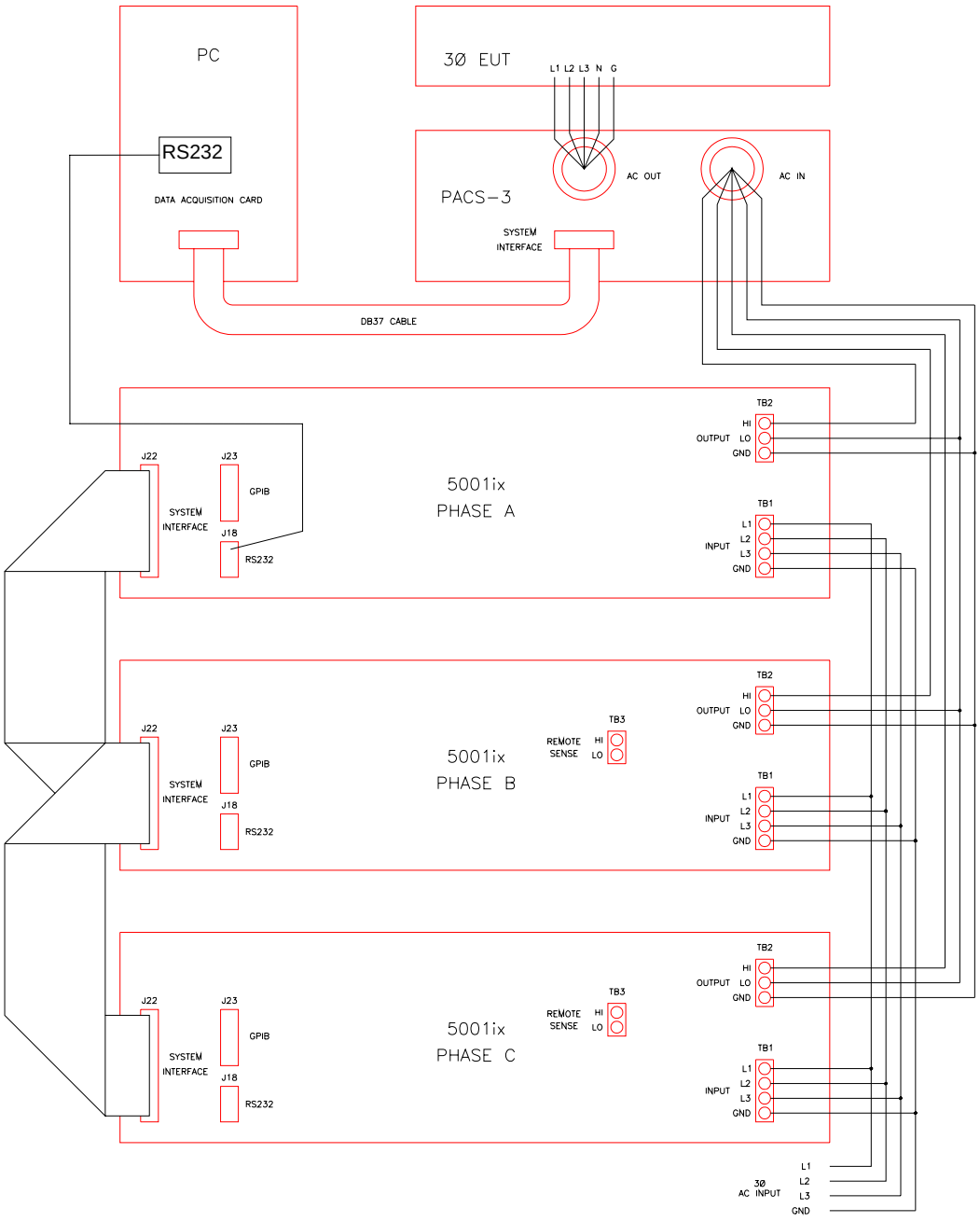


Figure 3-6: Three-phase configuration 15003iX-CTS

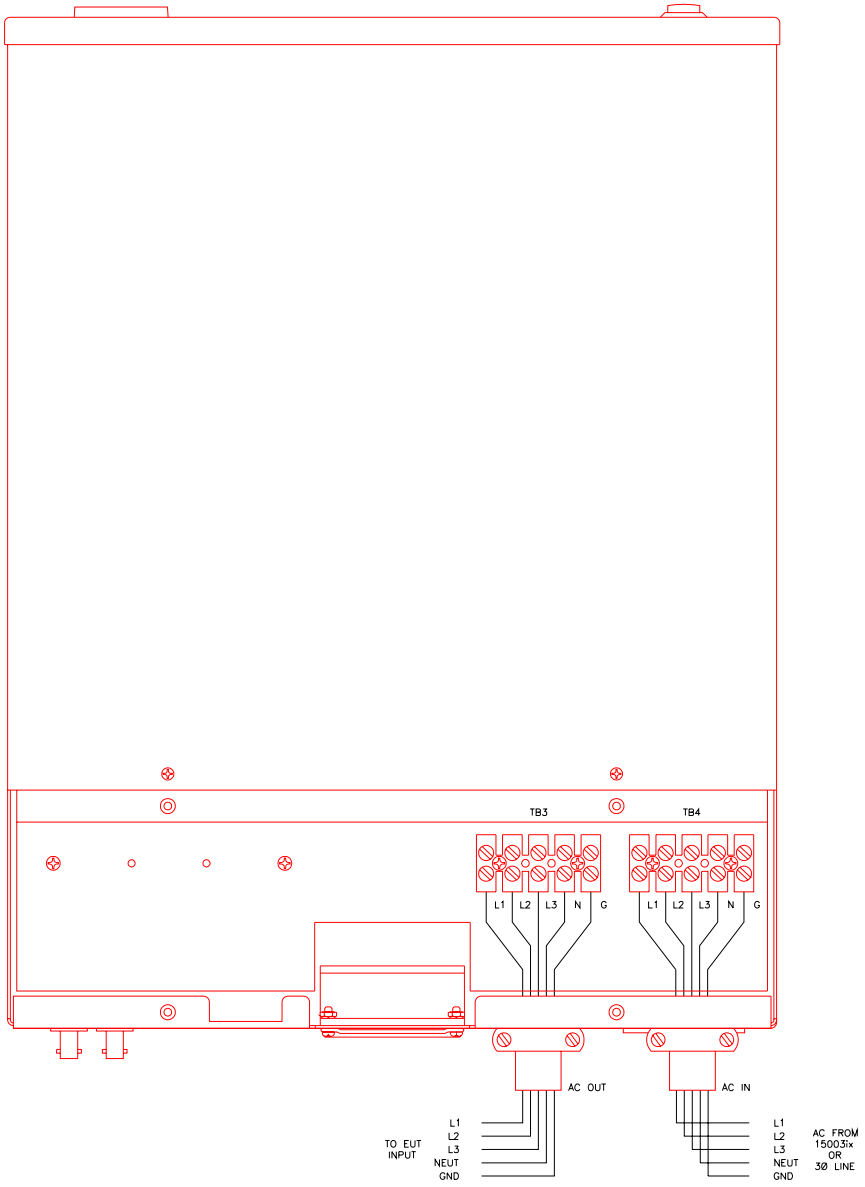


Figure 3-7: Power Connections for PACS-3 in a three-phase CTS.

3.6 Front Panel Connections and Controls

The front panel incorporates three functional areas:

- Output Sockets/Connectors
- Status Indicator lights
- Switch/Button controls

3.6.1 Output Sockets/ Connectors

PACS-1, PACS-3 and PACS-3-75

PC Interface Connector located on front panel is in parallel with the rear panel connector. Use front panel interface connector if rear panel access is difficult.

PACS-1 ONLY

The Output Socket is located on the right side of the front panel. It provides connection to a European CEE7/7 plug. This socket is connected to the same point as the rear panel AC output connector TB3. Keep in mind that this socket is rated for 16A only, while the rear terminals at TB3 are rated for 40A.

3.6.2 Status Indicator Lights

PACS-1 and PACS-3

The “ON “ LED indicates The PACS module is powered up. Note: Even if the PACS unit is powered down, the AC input terminals may still be live if the applied source has not been shut down.

PACS-1 and PACS-1RP

The BYPASS LED indicates the internal test impedance network is bypassed with relays.

The FLICKER LED indicates the internal test impedance is connected to the output for compliance testing.

Note: If the PACS-1 does not have the optional reference impedance installed, then the bypass LED will stay lit permanently and the flicker/bypass button will have no effect.

3.6.3 Switch/Button Controls

PACS-1 and PACS-3

The front panel power switch located on the left hand side of the PACS unit energizes the measurement circuits.

PACS-1

The Flicker/Bypass button toggles the internal impedance on and off, the FLICKER and BYPASS LEDs indicate which state the circuit is in.

Keep in mind that the internal impedance network can be switched in or out manually from the front panel, or, remotely by the flicker software. The default setting for the flicker relay control is remote via the DB37 connector.

Should it be desired to enable the front panel flicker control, it will be necessary to remove the top cover of the PACS-1 unit and set selector switches S1-1and S1-2. This light blue switch assembly is located on the AC Sensor board towards the front and left hand side of the PACS unit. See Figure 33 on page 105 for circuit board orientation . See figures on next page for proper switch orientation.

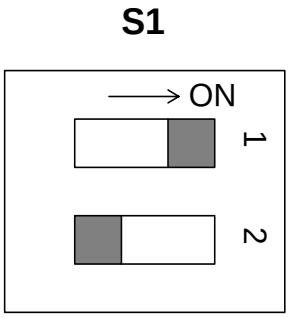


Figure 3-8: Switch Settings for Remote Impedance Control (Factory Default)

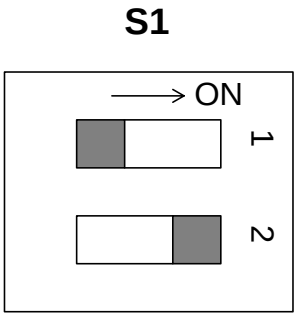


Figure 3-9: Switch Settings for Manual Impedance Control

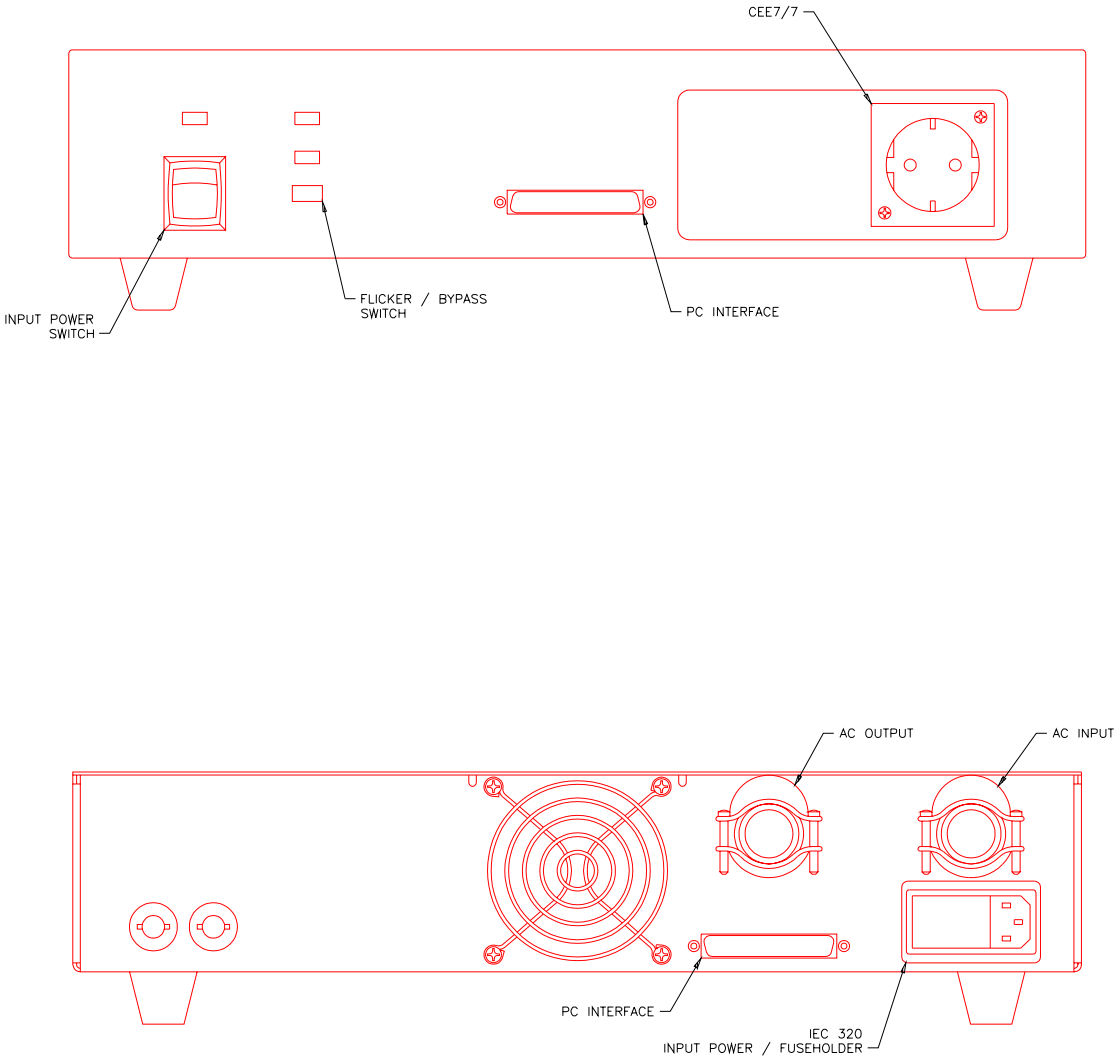


Figure 3-10: Front and Rear Panel Views of the PACS-1 Module.

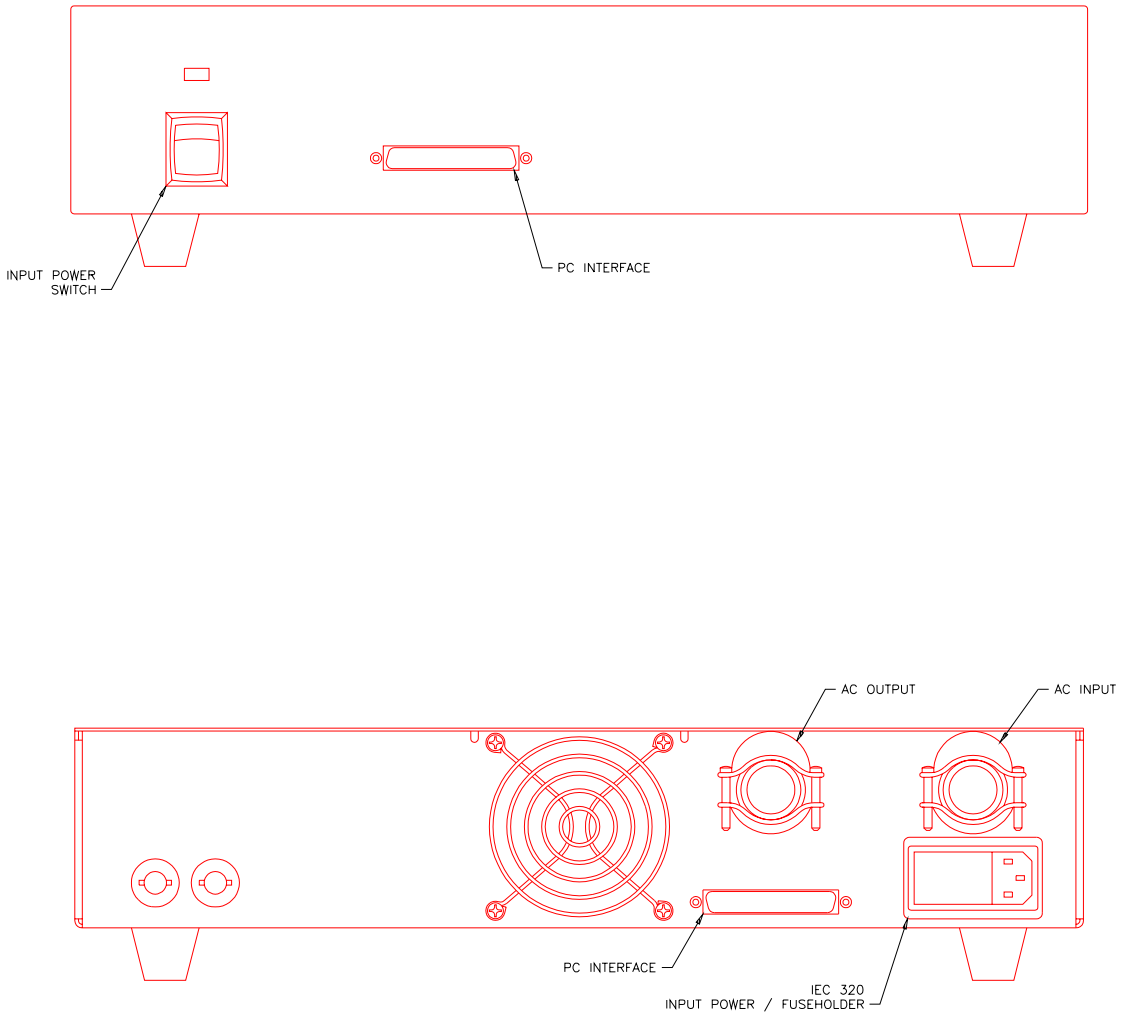


Figure 3-11: Front and Rear Panel Views of the PACS-3 Module.

3.7 Rear Panel Connections and Controls

The rear panel incorporates three functional areas

- PACS AC input supply.
- Measurement input/output connections.
- PC interface, Clock and Lock interface.

3.7.1 PACS AC Input Supply

The AC input to the PACS unit is on the right side of the rear panel. The molded cord plugs into the combination range change/ fuse holder assembly.

The AC power input module has a red plastic fuse holder that also serves as the input voltage range selecting device. The selected voltage range (115V or 230V) is displayed through a small rectangular window.

To change the fuse:
1. Remove power cord from input module.
2. Pry cover loose with a small screwdriver.
3. Pull out fuse holder, prying with a screwdriver will be necessary.
4. Replace ½ A fuse and reassemble in reverse order.

To change input range:
1. Remove power cord from input module.
2. Pry cover loose with a small screwdriver.
3. Pull out fuse holder, prying with a screwdriver will be necessary.

   Orient the red fuse holder so that the desired voltage shows through the window. While holding the two fuses in the holder, reinsert the fuse module and close the cover.

3.7.2 Measurement Input / Output Connections

The AC power input to be measured must pass through the cable strain relief clamp at AC INPUT and then to connector TB4, located just behind the rear panel. Similarly, the wires from TB3 are routed through the cable clamp at AC OUTPUT to the Equipment Under Test. To gain access to power connectors TB3 and TB4 the access panel located on the top rear of the unit must be removed. Remove the four screws holding the connector access panel in place and remove the panel. Once input and output wiring is complete, reattach the connector access panel.

3.7.3 PC Interface, Clock and Lock Interface

The PC interface connector accepts the DB-37 interface cable that goes to the PC with the AD Card and the CTS 3.0 Software.

Note: When connecting the high density 68 pin connector to the back of the A/D card in the PC, make sure to align the cable plug with the A/D card connector carefully so as not to bent any pin. The connector should insert easily. If undue force is needed, the plug may not be aligned properly or one or more pins may be bent. Check the plug and connector carefully before installing the supplied cable between the PACS and the PC.

The CLOCK and LOCK BNC connectors are available for future interface capabilities to CI power sources.

3.8 Data Acquisition Card Installation - PCI Card Version

All measurements in the CTS System are performed through a dedicated data acquisition card that needs to be installed in the host PC. The PC that this card is being installed in must have at least 512 Mbyte of RAM memory for the card and software program to work correctly. This section provides the necessary installation procedure for both hardware and software of the PCI version A/D Card. The PCI card is a Windows compliant Plug-n-Play card that requires a single PCI slot in the test system PC. The card driver is installed along with the CTS 3.0 software.

3.8.1 Unpacking and Handling

The following items are included as part of the CTS System A/D Card kit:

1. A/D conversion board, Exacq PCI card (CI401PCI P/N 250803 for PACS1 or CI403PCI P/N 250797 for PACS3).
   or
   A/D conversion board, National Instruments M Series PCI-6220 (P/N 250821) for PACS1 or PCI-6250 (P/N 250822) for PACS3.
2. 68 to 37 pin adapter cable, HD68 (High Density) male to DB37 male connector. For Exacq card, supplied cable is P/N 250798. For NI M Series A/D card, supplied cable is P/N 5004-229-1.
3. CIC632 CD ROM with CTS30 software and Exacq card drivers. NI M Series card drivers are supplied on NI CD ROM included.
4. CD ROM with calibration data.

Verify that all components are available. The CTS system will not operate if any of these items are missing. If any item is missing or visibly damaged, contact California Instruments customer service department immediately. Refer to page 3 for details on contacting California Instruments. Retain the original packaging material for the card and its accessories in the event you ever need to return the PCI A/D card to California Instruments.

Keep the PCI card in its protective anti-static bag until you are ready to install it in an available PCI slot of the host PC. This will minimize the chance of damage due to electrostatic discharge. When you finally do remove the card from the bag, make sure you are wearing a wrist ground strap and hold the card by its edge to avoid touching any of the components.

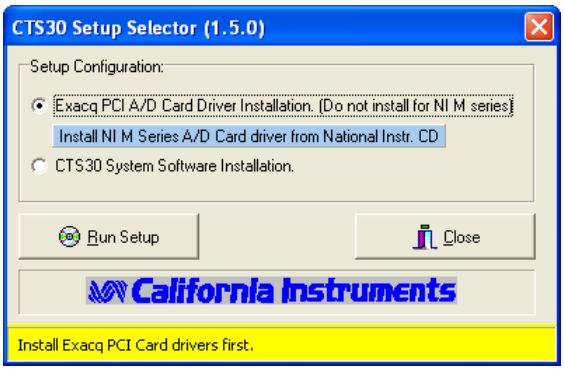
There are no jumpers of DIP-switch settings on the PCI A/D card as all configuration data is retained in EEPROM.

The correct order of installation is:

1. Install the PCI Card drivers from the CIC632 (Exacq Technologies driver) CD ROM.
2. Turn off the PC and install the PCI A/D card in an available PCI slot.
3. Reboot the PC and let Windows find the A/D card and complete installation of the drivers.
4. Install the CTS30 software from the CIC632 CD ROM.

Note: For systems furnished with (National Instruments E Series or M Series) A/D card type, do not install the Exacq card drivers from the CIC632 CD ROM but use the supplied National Instruments CD ROM to install the A/D card driver first.

3.8.2 Installing the PCI Card Driver Software


CTS30 Setup Selector (1.5.0)
Setup Configuration:
Exacq PCI A/D Card Driver Installation. (Do not install for NI M series)
Install NI M Series A/D Card driver from National Instr. CD
CTS30 System Software Installation.
Run Setup
Close
California Instruments
Install Exacq PCI Card drivers first.

Insert the National Instruments NI-DAQ distribution or the CIC632 (Exacq Technologies driver) CD-ROM in the CD ROM drive. The setup.exe program should start if the CD ROM drive is configured for AutoStart. If not, double click on the Setup.exe program to launch the installation wizard.

Follow the installation prompts for the Driver installation to install the A/D Card drivers.

3.8.3 Installing the PCI A/D Card

Following the procedure outlined below to install the PCI card in the test system PC:

1. Disconnect your PC from any main power.
2. If possible, wear a grounded wrist strap to prevent ESD damage to the PC and the A/D Card and place the PC cabinet on a firm ESD safe working surface.
3. Remove the cover of the PC cabinet following the directions provided by the PC manufacturer.
4. Locate the PC's PCI bus expansion slots. The CI40nPCI requires a single 32 bit PCI slot.
5. Using a suitable screwdriver (typically Phillips #2), remove the cover plate for the slot you opted to use in step 4. The A/D card has its own cover plate so the one you remove may be saved or discarded at your own discretion. You will need to re-use the screw however, so make sure you do not loose it.
6. Carefully remove the PCI card from its protective bag and hold it along the top edge. Take care not to touch the gold finger edge connectors at the bottom.
7. Insert the card carefully in the selected slot making sure the DB68 connector clears the slot in the back of the PC. Press down firmly along the top edge of the board to make sure the board is seated properly in the PCI slot connector. It may help to rock the board gently or start from one end of the edge connector.
8. Install the screw you removed in step 5 and secure the PCI board to the PC slot by its cover plate.
9. If you plan to use an IEEE-488 Controller to communicate with the AC Source and have not installed one in the host PC yet, now would be a good time to do so. Follow the Bus Controller manufacturer's instructions for installation.
10. Replace the PC's cover following the directions provided by the PC manufacturer.

Note: When connecting the high density 68 pin connector to the back of the A/D card in the PC, make sure to align the cable plug with the A/D card connector carefully so as not to bent any pin. The connector should insert easily. If undue force is needed, the plug may not be aligned properly or one or more pins may be bent. Check the plug and connector carefully before installing the supplied cable between the PACS-3-75 and the PC.

3.8.4 Testing the Exacq Technologies PCI card (CI401PCI, CI403PCI)

Note: If the CTS system was supplied with the National Instruments E Series A/D card, refer to section 3.8.5 instead.

Card Reference numbers:

CI Designation	Exacq P/N	System
CI401PCI	CM2110	Single phase systems
CI403PCI	CM2210	Three phase systems

After installing the A/D card in an available PCI slot, you must configure the card for operation in the CTS. Generally, the PCI card will be the only A/D card to be used in your PC, but in case there are more cards present, contact the factory for details concerning multi-card configuration.

After installing the PCI card, turn the computer back on. When Microsoft Windows starts up, it should discover the new Exacq A/D device.

Next, you need to test the A/D card in your computer, and configure the A/D card for use with the CTS software. After the PC starts up, you will have a new Program Group, called Exacq. Start the application called Exacq Control Center from this new Exacq program group on the Windows Start menu. See Figure 3-12 below.

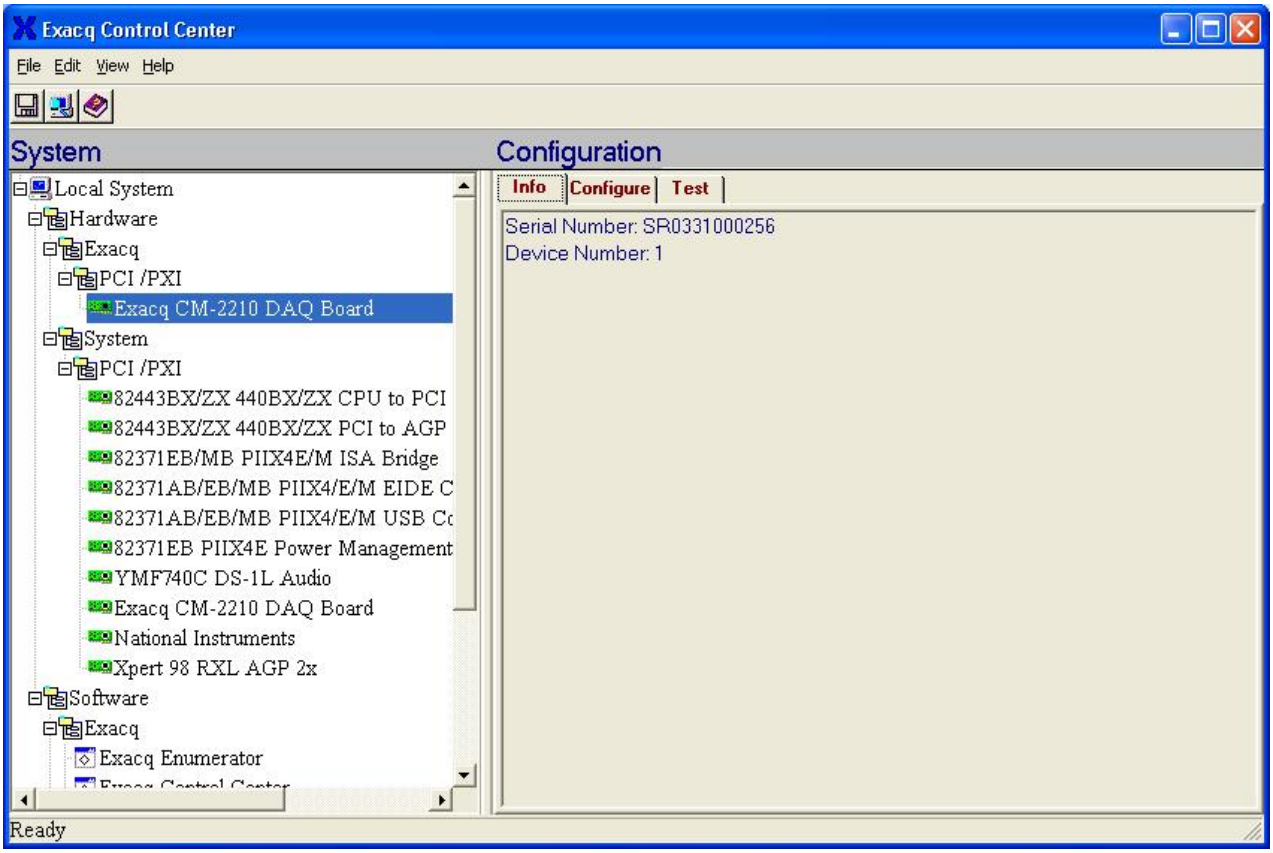


Figure 3-12: Exacq Control Center Screen.

The new data acquisition card will appear as a node in the LocalSystem | Hardware | Exacq | PCI/PXI branch of the System tree.

Click on this node. The serial number and logical device number will display in the Configuration pane. The logical device number is the identification that application software such as the CTS uses to specify which hardware device will be used. This device number should only be changed if you have multiple A/D cards in the PC. See Figure 3-13 below).

Otherwise, leave the number as is. In the event this is necessary, you may change the assigned device number by clicking on the configuration tab and selecting a new number using the device number edit control. Only knowledgeable users should make changes to these settings.

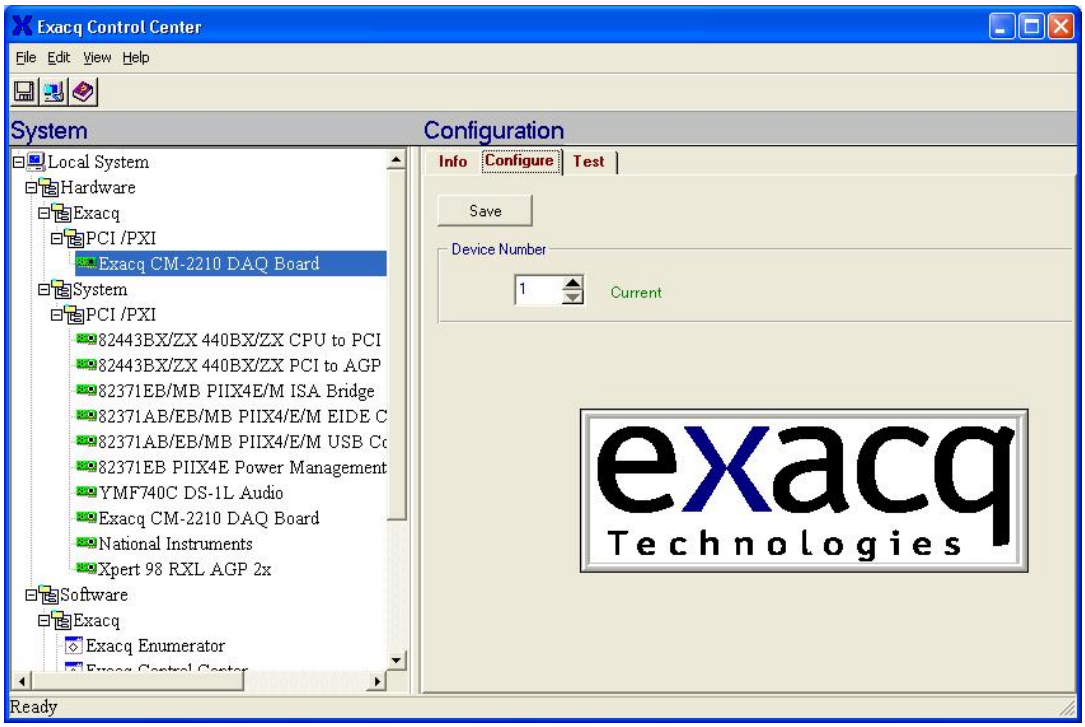


Figure 3-13: Exacq Card Device Number

You are now ready to verify that the A/D card functions properly in your PC. To do so, select the "Test" tab in the Configuration panel. This will bring up the test panel (see illustrations Figure 3-14, Figure 3-15 and Figure 3-16 on following pages). This test panel can be used to test all analog input channels and analog output channels as well as the digital IO lines. You can test Channel 0 (zero) as shown below. Assuming you have connected the interface cable to the PACS signal-conditioning unit, and the PACS receives the supply from the power source, the display will look similar to the figure below. Assuming the card functions properly, installation and configuration of the Exacq data acquisition hardware and software is now complete.

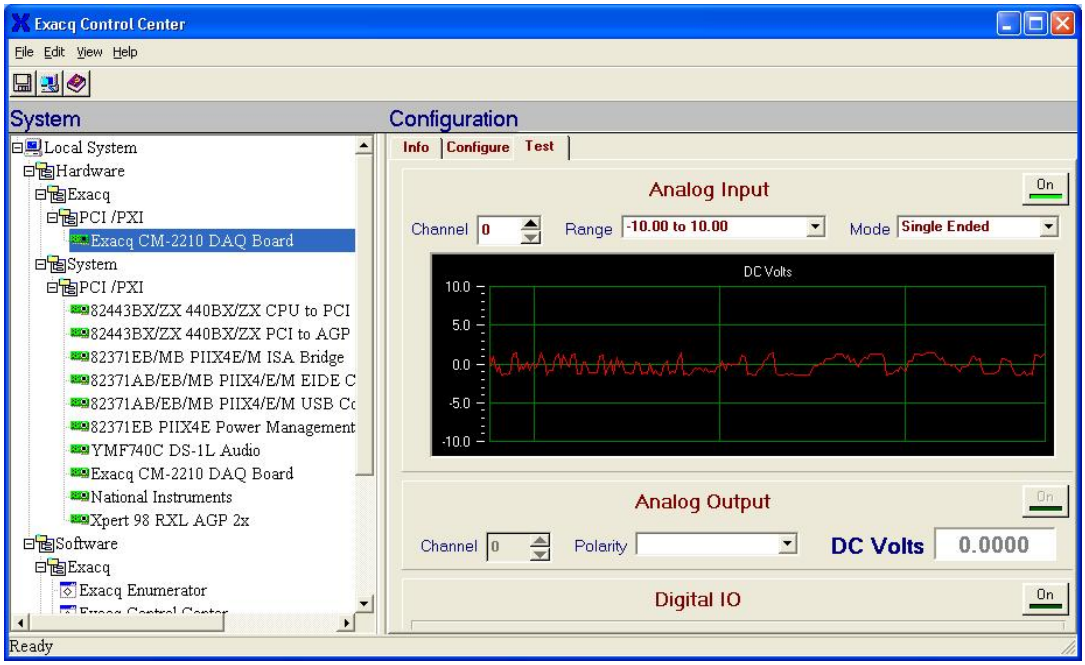


Figure 3-14: Exacq Test Panel

You can run the Exacq Bench software to do a further functional check of the CTS hardware, and interconnect cable between the A/D card and the PACS (CTS signal conditioning unit). Close the Exacq Control Center window. Start the application called Exacq Bench from this new Exacq program group on the Windows Start menu.

Make sure the PACS is powered up, and the A/D card cable is properly attached to both the card, and the PACS. Of course, the power source needs to be operating, and must supply an appropriate voltage to the measurement system.

You may now apply a load to the CTS. Typically, this will be the 230 Volt – 50 Hz supply voltage that is used to power the products to be tested. This voltage is routed to logical channel 0 of the A/D card, via a differential input amplifier and a 100: 1 attenuation factor in the PACS. On the Exacq Bench menu bar, select “Instrument”, “Volt Meter”. Thus, the Exacq Bench DVM function will display approximately 1.00 volt for a 100 Volt AC voltage setting of the power source, such as may be used in Japan (see the example of the DVM function below). The display should be about 2.30 Volt rms for a 230 Volt – 50 Hz input voltage. Note that the system calibration will eliminate small errors due to hardware tolerances. Thus, the ratio is not necessarily exactly 100:1.

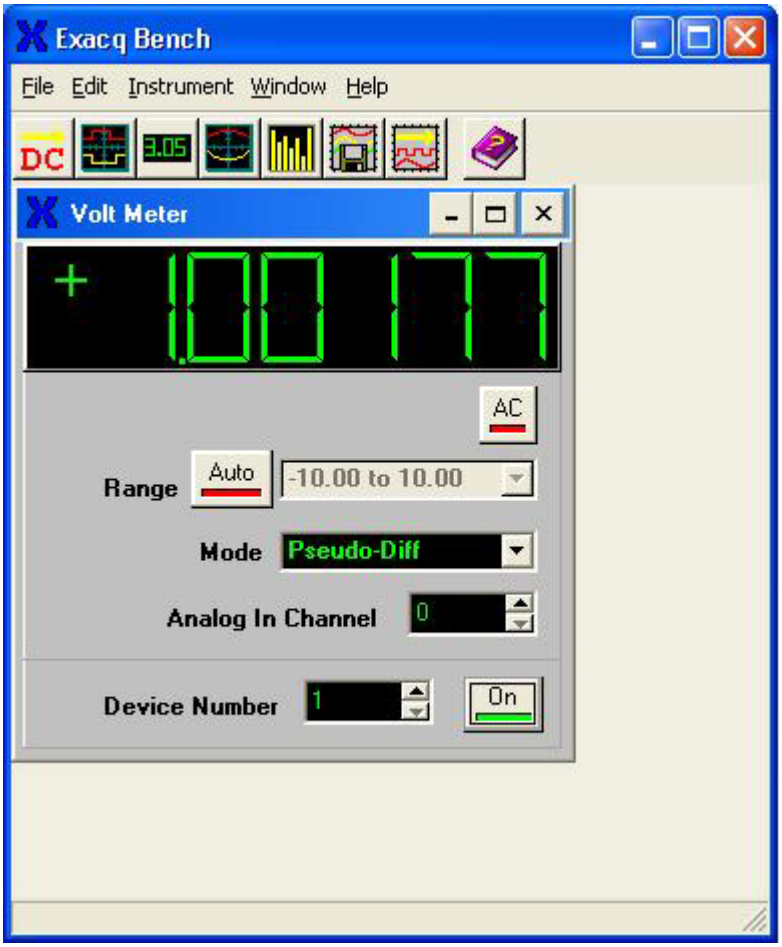


Figure 3-15: Exacq DMM Screen

Of course, you may also use the oscilloscope function of the Exacq Bench to display the time domain signals. Refer to the appropriate section of this manual to identify all the signals and channel numbers, but for this example, channel 0 is for voltage, and channels 1,2,3 are the (parallel) three current signals. In the figure below, channel 0 and 3 are displayed (channel 3 is the most sensitive current channel). The CTS power source was set to 230 Volt – 50 Hz, and a resistive load with a dimmer set to approximately 90 degrees firing angle was applied. The (yellow) current signal was 2.0 Amp rms and the (red) voltage was 230 Volt. The settings for the scope channels and time base function were adjusted to obtain the display as shown in the figure.

Upon completion of the above tests, you may proceed with installing the CTS software modules that were supplied with your system.

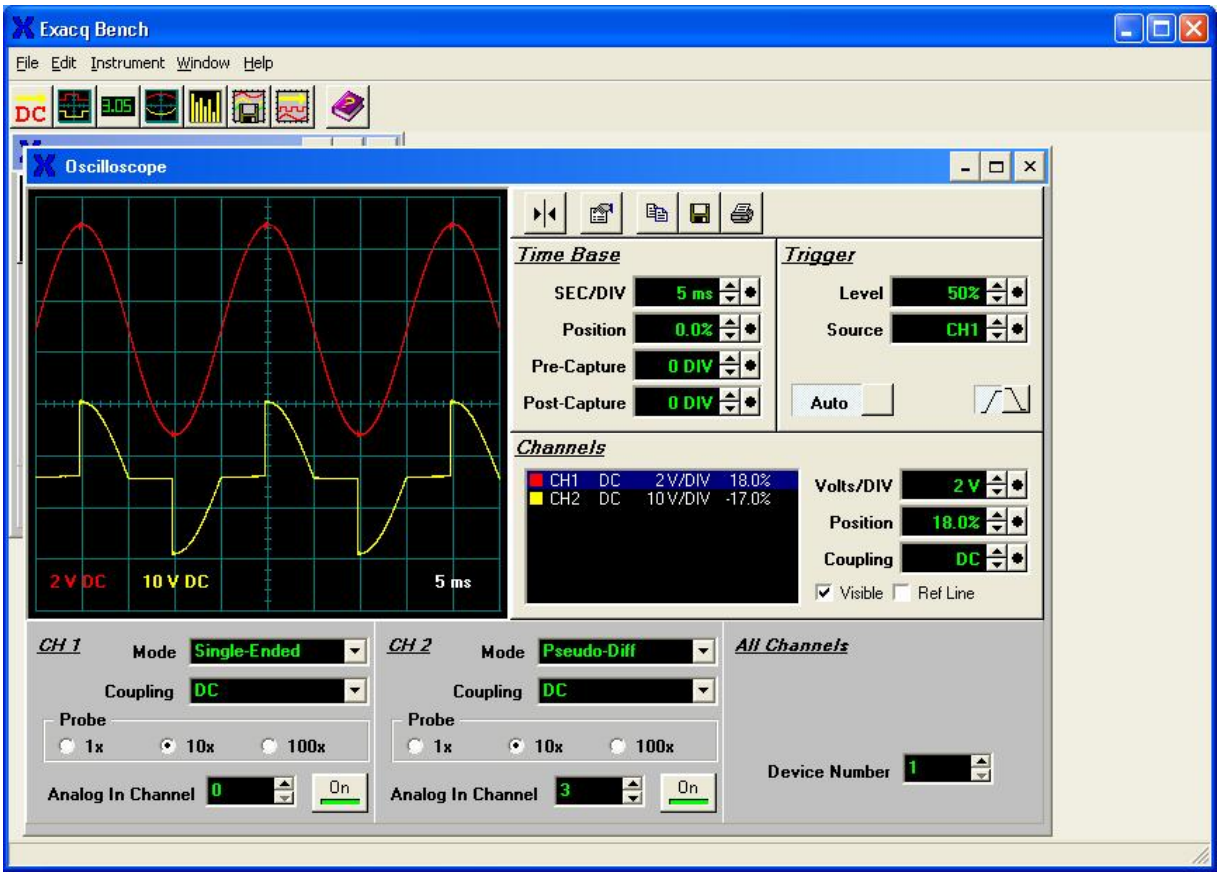


Figure 3-16: Exacq Scope Test Panel

3.8.5 Testing the National Instruments PCI Card

E-Series DAQ Board

CTS 3.0 must be installed first before performing a A/D card testing. After CTS 3.0 is installed, the PC must be rebooted. The new hardware should be detected automatically at boot by the Windows™ operating system. Follow the on-screen prompts to finish installation of the A/D card.

Once the PCI A/D card is installed and the PC has been re-booted, you should see a "Measurement and Automation" icon on the desktop. Double click on it and expand the Devices and Interfaces tree, you will now see the PCI card you installed as shown in the screen below.

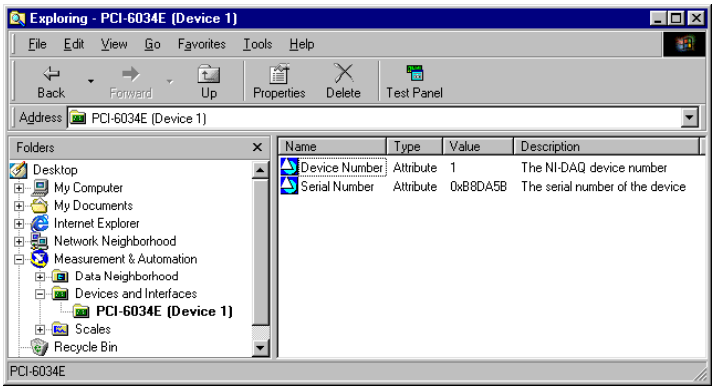


Figure 3-17: NI E Series Explorer Panel

M-Series DAQ Board

Launch Measurement and Automation, select NI-DAQmx Devices, NI PCI-6250: "Dev1".

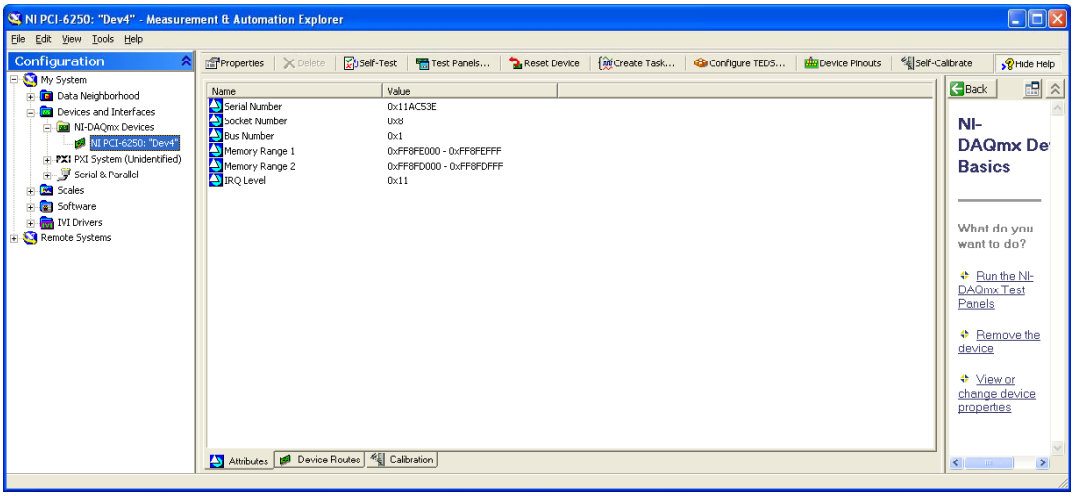


Figure 3-18: Figure 3 18: NI M Series Explorer Panel

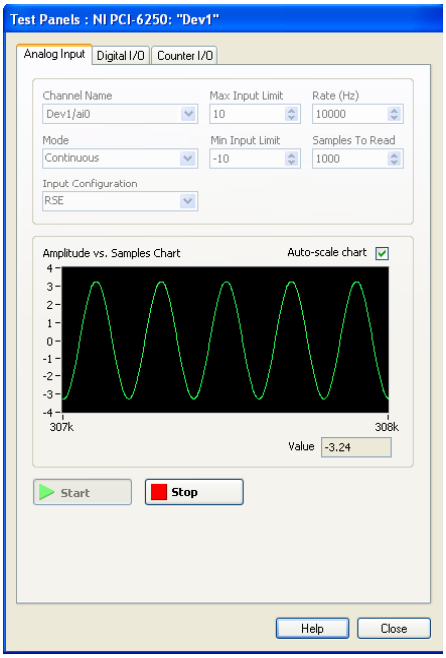
Select “Self-Test” and you should get the pop-up message below.

You can run “Test Panels…” to do a further functional check of the CTS hardware, and interconnect cable between the A/D card and the PACS (CTS signal conditioning unit).

Highlight NI PCI-6250: “Dev1”, select “Test Panels…”, set Channel Name to “Dev1/ai0”, set Mode to continuous, set Input Configuration to RSE, set Rate(Hz) to 10000.

Make sure the PACS is powered up, and the A/D card cable is properly attached to both the card, and the PACS. Of course, the power source needs to be operating, and must supply an appropriate voltage to the measurement system.

Set the power source to 230 Volt – 50 Hz. This voltage is routed to logical channel 0 of the A/D card, via a differential input amplifier and a 100: 1 attenuation factor in the PACS. The display should be about 2.30 Volt rms for a 230 Volt – 50 Hz input voltage. (See below picture for detail)



3.8.6 CTS / GPIB Software Setting Conflict

Each time the CTS is run, a function is called to initialize the A/D card. This call, "Init_DA_brds", actually does more than A/D initialization. It also sends some commands to the instrument with GPIB address #1 when using a NI GPIB controller. The AC source if used over the IEEE-488 bus is factory set to address 1. This may cause a problem unless the IEEE-488 address on the power source is changed to an address other than 1.

The address can be left at 1 on the power source if needed by changing the visaconf.ini file. This file is typically residing in "c\vxipnp\win95\nivisa" directory. (If not located in this directory, use the Windows Explorer Find function to locate this file.) This file is not distributed with the CTS

software. It is installed when the National Instruments GPIB software is installed. There is a line under [GPIB-VXI-CONFIG]: DisableAutoFind=0. The 0 needs to be changed to 1.

3.9 Data Acquisition Card Installation – Legacy ISA Card Version

The ISA A/D card is no longer supported by the CTS30 software version 3.0.16 and higher. If you are upgrading to CTS30 revision 3.0.16 or higher, you MUST upgrade to one of the supported PCI data acquisition cards. The information in this section is provided for users of older systems only that have not yet upgraded.

All measurements in the CTS System are performed through a dedicated data acquisition card that needs to be installed in the host PC. This section provides the necessary installation procedure for both hardware and software of the ISA version A/D Card.

Note: The ISA card is no longer supplied with new CTS systems as the ISA bus is obsolete. This information is provided to support existing CTS system installations that were originally purchased with the ISA bus A/D card.

3.9.1 Unpacking and Handling

The following items are included as part of the ISA CI400AD:

- A/D conversion board, 3/4 size ISA card.
- 37 pin cable, DB37 male to DB37 female connector.

Verify that all components are available. The CTS system will not operate if any of these items is missing. If any item is missing or visibly damaged, contact California Instruments customer service department immediately. Refer to page 3 for details on contacting California Instruments. Retain the original packaging material for the card and its accessories in the event you ever need to return the ISA CI400AD A/D card to California Instruments.

Keep the ISA CI400AD card in its protective anti-static bag until you are ready to install it in an available ISA slot of the host PC. This will minimize the chance of damage due to electrostatic discharge. When you finally do remove the card from the bag, make sure you are wearing a wrist ground strap and hold the card by its edge to avoid touching any of the components.

3.9.2 ISA A/D Card Configuration

The CI400AD card has two jumpers that must be set in the correct position before the board is installed in the host PC. Also, the base I/O address of the CI400AD card is set by means of a DIP switch. This switch must be set to a suitable I/O address that does not conflict with any other I/O peripherals in the host PC.

The location of the jumpers and the I/O address DIP-switch are shown in Figure 3-19.

Figure 3-19: Jumper and DIP switch location on the A/D Card

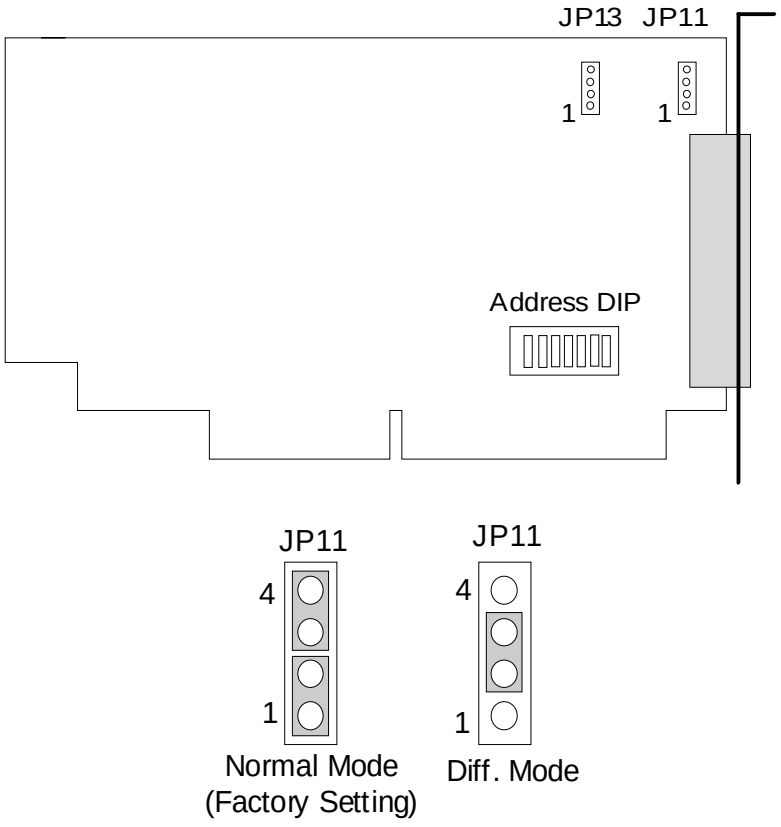


Figure 3-20: A/D Card JMP 11 Settings

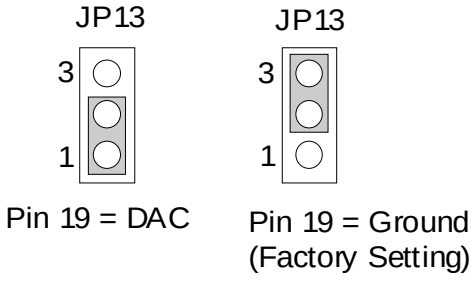


Figure 3-21: A/D Card JMP 13 Settings

Jumper JP11

Jumper JP11 selects between differential or single ended input channel mode and should be set to single ended mode for the CTS system. The correct setting is shown in Figure 3-20. Pin 1 and 2 are jumpered together as are pins 3 and 4. This is the setting in which the board is shipped from the factory and you should not have to change it.

Jumper JP13

Jumper JP13 affects the purpose of pin 19 on the 37-pin connector that interfaces to the PACS unit. For CTS operation, this pin must be analog ground and this jumper must connect pin 2 and 3.

DIP Switch - Base I/O Address

The DIP switch located on the CI400AD sets the base I/O address in the host PC I/O space. The factory configuration is port address 0x180. In most cases, this port address is available (not used by other PC peripherals) and no changes to this setting are needed.

If you do have a conflict with another device in your PC, you will have to reconfigure the base I/O address of the CI400AD. The CI400AD uses 8 contiguous I/O port addresses. Each peripheral must have a unique I/O address and no overlap can exist. The PC architecture reserves 1024 bytes of I/O space for general purpose I/O boards. However, not all of this space is generally available. The following table shows a list of commonly used I/O addresses. Use this table to locate an I/O space that is available in the host PC.

Table 3-2: Reserved PC I/O Address Locations

Hex I/O Range	Typically used by
170-177	Fixed disk controller #2
1F0-1F7	Fixed disk controller #1
200-207	Joystick Game Port
238-23C	Bus Mouse
23C-23F	Alternate Bus Mouse
278-27F	Parallel Printer Port (LPT)
2B0-2DF	EGA Display Adapter.
2E0-2E7	GPIB Controller card
2E8-2EF	Serial Port (COM)
2F8-2FF	Serial Port (COM)
300-31F	Prototype Card
320-32F	Hard Disk Controller (PC-XT)
360-36F	Reserved
370-377	Floppy Disk Controller #2
378-37F	Parallel Printer Port (LPT)
380-38F	Serial Data Link Controller
3A0-3AF	Serial Data Link Controller
3B0-3BB	Monochrome Display Adapter
3BC-3BF	Parallel Printer Port (LPT)
3C0-3CF	VGA, EGA Display Adapter
3D0-3DF	CGA Display Adapter
3E8-3EF	Serial Port (COM)
3F0-3F7	Floppy Disk Controller #1
3F8-3FF	Serial Port (COM)

The CI400AD base I/O address is set using the DIP switch. The DIP switch positions 1 through 7 correspond to bits 9 through 3 of the I/O address. This allows a range of 0x100 to 0x3F8 in eight byte increments. A switch in the ON position signifies the address line is 0 for the bit it represents. A switch in the OFF position signifies a 1 for the bit it represents. The following figure shows the bit mapping and the default factory setting of 0x180.

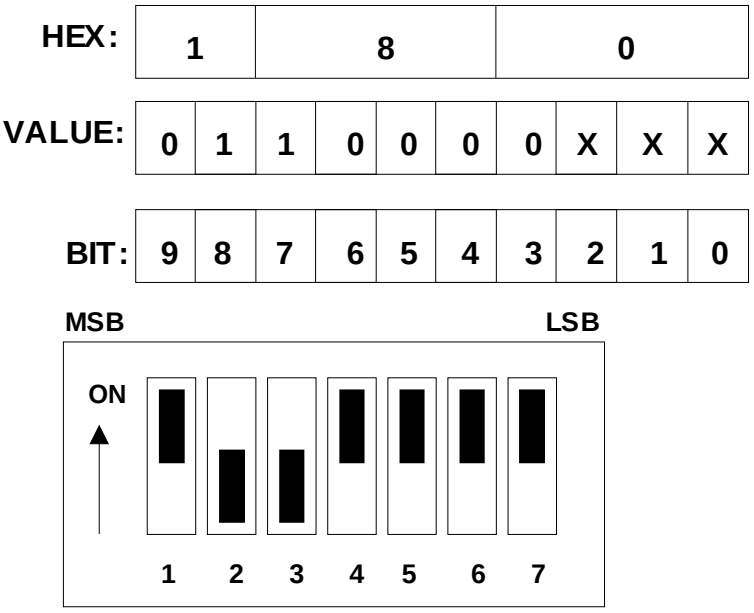


Figure 3-22: A/D Card Base I/O Address DIP

If you need to change the factory default I/O address to a different value to avoid conflicts with other I/O boards in your PC, you must note down the new address and pass it as a parameter when setting up the software driver later.

3.9.3 Installing the ISA A/D Card

After you have configured the jumpers and the DIP switch on the A/D card (if factory defaults are not usable), you are ready to install the CI400AD in your PC. Following the procedure outlined below:

1. Disconnect your PC from any main power.
2. If possible, wear a grounded wrist strap to prevent ESD damage to the PC and the A/D Card and place the PC cabinet on a firm ESD safe working surface.
3. Remove the cover of the PC cabinet following the directions provided by the PC manufacturer.
4. Locate the PC's ISA bus expansion slots. The CI400AD requires a single 16 bit ISA slot. Note that these slots have two edge connectors.
5. Using a suitable screwdriver (typically Phillips #2), remove the cover plate for the slot you opted to use in step 4. The CI400AD has its own cover plate so the one you remove may be saved or discarded at your own discretion. You will need to re-use the screw however, so make sure you do not loose it.
6. Carefully remove the CI400AD from its protective bag and hold it along the top edge. Take care not to touch the gold finger edge connectors at the bottom.
7. Insert the card carefully in the selected slot making sure the DB37 connector clears the slot in the back of the PC. Press down firmly along the top edge of the board to make sure the board is seated properly in the ISA slot connectors. It may help to rock the board gently or start from one end of the edge connector.
8. Install the screw you removed in step 5 and secure the CI400AD board to the PC slot by its cover plate.
9. If you plan to use an IEEE-488 Controller to communicate with the AC Source and have not installed one in the host PC yet, now would be a good time to do so. Follow the Bus Controller manufacturer's instructions for installation.
10. Replace the PC's cover following the directions provided by the PC manufacturer.

This completes the board installation. You are now ready to install the CTS 3.0 Software.

3.10 CTS 3.0 Software Installation

Once the card drivers have been installed, the CTS 3.0 software can be installed next. This requires the use of the CTS 3.0 installer program provided on CD ROM CIC632.

To install the CTS 3.0 software, the CD ROM or floppy disk containing the calibration coefficients must be inserted in the relevant PC's drive first. If either of these disks is not available, the installation can still be performed but the system may not be in calibration.

The CTS 3.0 system software is supplied on a CD-ROM, P/N CIC632. The CD-ROM contains compressed files that are needed to operate the CTS system properly. Since these files are in compressed form, they should not be copied to your PC's hard disk since they will not function in this form. Instead, the setup program that is included on the CD-ROM should be used to install all the files.

An additional CD ROM is provided containing the system calibration data. Please note that if the CTS 3.0 is to upgrade an existing CTS system, the calibration CD ROM will not be included as the system was calibrated before.

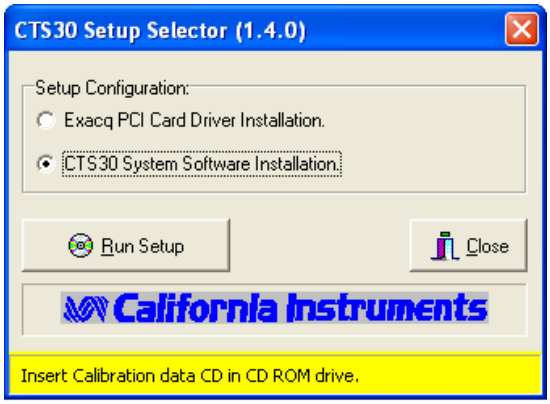
For CTS systems supplied with the National Instruments E Series A/D card, the NI-DAQ driver is provided on a separate CD ROM.

3.10.1 Installing the CTS 3.0 Software Under Windows™

This section covers installation of the CTS 3.0 software under Window™.

To install the CTS 3.0 software, proceed as follows:

1. Insert the CIC632 CD-ROM into your CD-ROM drive and wait a moment for the drive to recognize the CD.
2. The program should start automatically. If not, select **Start**->**Run**… from the Windows Start menu and type D:\setup.exe, assuming your CD-ROM is the D drive.
3. If this is a PCI A/D card based system, the card and drivers for the card should have been installed already at this point. If not, go back and do so now.
4. Remove the CIC632 installation CD and replace it with the Calibration Data CD that came with the CTS system.
5. Select "CTS 3.0 System Software Installation for PCI A/D Card and click on the Run Setup button.



6. The program will now copy the calibration data from the CD ROM to you PC's root directory.
7. You will now be prompted to re-insert the CIC632 installation CD ROM.
8. Remove the Calibration CD and replace it with the CIC632 installation CD. The CI browser may reappear when you close the CD drive door as your CD drive may be set to autorun. You can either ignore or close the second instance of the CI Browser program.
9. Click the OK button to confirm that the CIC632 CD is back in the CD ROM drive. This will launch the CTS 3.0 installation program.
10. Follow the on screen installation program prompts to complete the CTS 3.0 system software setup.

11. Once completed, you can remove the CD-ROM. You may have to reboot the computer after the software installation. This will be indicated at the end of the installation program.

12. Before launching the CTS software, run the “DAQ Card Selector” module to choose the correct A/D card for the CTS. The “DAQ Card Selector” module is located in the application directory (C:\Program Files\California Instruments\CTS30). You can also run this module from the program group by selecting “Start”, “All Programs”, “CTS30”, and then “DAQ Card Selector”. You only have to run this module once to select the correct A/D card for the system. If you happen to select a wrong card then run the module again to choose the correct A/D card.

The installation program will create a new entry in the Programs Menu called Compliance Test System. This menu has several sub-menu entries, one for the main test program and several for the calibration and configuration programs as well as a few utility programs. We recommend you keep the calibration disk and CD-ROM in a safe place in case you ever need to re-install the CTS 3.0 software.

Note: To operate the AC source through the IEEE-488 interface, it may be necessary to install the IEEE-488 controller card drivers on the same PC. Refer to the setup instructions supplied with the IEEE controller card.

3.10.2 Calibration Data distributed on Floppy Disk

On older CTS systems, the calibration data for each system was distributed on Floppy disk. As this old medium is rapidly disappearing, CD ROM is used on newer systems.

If the calibration data you received was provided on floppy disk instead of CD ROM, you will have to copy the following file from this floppy to your hard drive root directory (Usually C:\) using Windows Explorer:

CTS Calibration.dat

3.11 AC Source Control Software Installation

If the CTS system you purchased contains a California Instruments AC power source, it will have included additional AC source control software as well. If you purchased a 100-CTS or 300-CTS, you can skip this section of the manual and proceed to the next chapter.

Note: The AC source control software is not required to perform harmonics and flicker tests. It is required to perform any of the IEC 61000-4 tests however. This software is supplied with its own user manual and we recommend you familiarize yourself with this user manual also when electing to use the AC source control software.

The AC source control software is supplied on either a set of standard 1.44 MB, 3.5 inch floppy disks or a CD-ROM. The actual software included depends on the AC source model included with the system. For 1251RP-CTS systems, the PGUI32 program is included. All other CTS configurations include the CIGui32 or CIGuiSII program.

These distribution disks contain compressed versions of all the programs and files needed to operate the AC source. Since these files are in compressed form, they should not be copied to your PC’s hard disk since they will not function in this form. Instead, the setup program that is included on this first disk should be used to install all the files.

To install the AC source control software, proceed as follows:

1. Insert the GUI CD-ROM in the PC's CD-ROM drive. If the drive is configured for autoboot, the CI CD-ROM Browser program should pop up on screen. If not, run the CI_SWCD.EXE program.

2. In the left window of the CD browser, locate the AC Source series for the AC source supplied with the CTS system.
3. Click on the Programs Tab on the right and select Windows 32 bit.
4. Click on the Install button at the bottom center to run the setup program.
5. Follow the on-screen prompts of the installation program.
6. The setup program will now run and display a dialog box that shows the default directory for the AC source control software that is CIGUI on the current drive. At this time you can accept the default directory by clicking on the OK button or enter a different directory. If the directory you enter does not already exist, it will be created.
7. At the end of the installation process, a message will be displayed indicating the installation is complete.
8. You can now remove the CD-ROM.

3.12 Upgrading from a CTS 1.X or CTS 2.0 System

If you are upgrading from a prior version of the CTS system, you can take full advantage of the enhanced capabilities of the CTS 3.0 software while retaining access to your existing revision software and data files. Since the data formats between CTS 1.X, 2.0 and CTS 3.0 are not compatible, we recommend you retain your original CTS version program disks and data files. The CTS 3.0 program installs in different directories and will not replace your existing CTS software installations.

Since the A/D card is already installed on an existing CTS system, you can proceed to the CTS 3.0 software installation section directly.

Note: Since version 3.0 supports additional data processing requirements dictated by new test standards, the PC may no longer be fast enough to process all the data in real-time. In that case, it may be necessary to upgrade the PC as well. For CTS 3.0 to run with the Inter harmonics per the future EN/ IEC 61000-4-7, a 667 MHz Celeron PC or better is needed for a single phase system and a 733 MHz Celeron or better is needed for a three phase system.

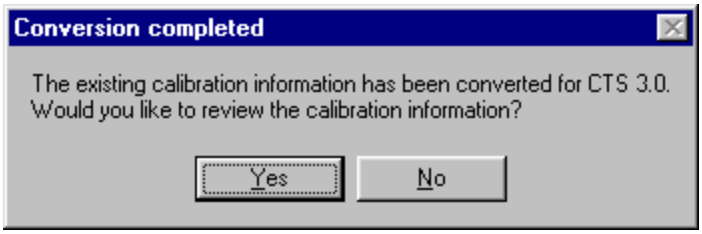
Note: For three phase CTS systems that use the ISA A/D card, the inter harmonics capability cannot be supported. An upgrade to the PCI A/D card will be required.

3.12.1 Transferring existing Calibration Data

Before using the new CTS 3.0 software, it is important to transfer the existing CTS 1.X calibration data to the CTS 3.0 calibration database. This will eliminate the need to recalibrate the system when upgrading. If the CTS system has not been calibrated in the past 12 months however, it is recommended to perform a calibration. In that case, there is no need to transfer the existing CTS 1.X calibration data. Also, systems operating with CTS 2.0 will automatically transfer their calibration data to CTS 3.0.

To transfer the CTS 1.X calibration data, proceed as follows:

1. Run the **Configuration** program in the **Compliance Test System** menu.
2. The first time the **Configuration** program is run and it detects the presence of the cal3c.dat file in the c:\iec1000 directory, it will automatically read in the data contained in this file and convert it to the CTS 3.0 calibration database.
3. A message will be displayed to inform the operator that the conversion has been completed. Select Yes to continue using the Configuration program for display of the calibration data. You will be presented with a log in screen. If you don't have the right password, you can still continue to view (but not edit) the calibration entries. Select No to close the Configuration program. There is no user password required when you select No. Once converted, the existing calibration data is automatically saved.

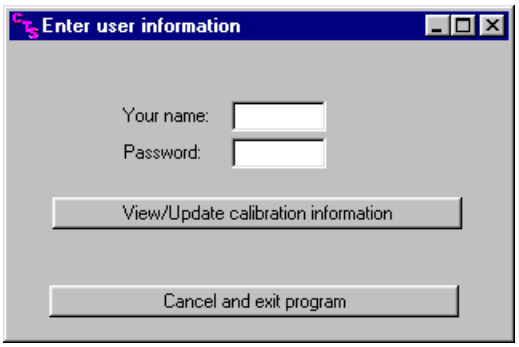

Conversion completed
The existing calibration information has been converted for CTS 3.0.
Would you like to review the calibration information?
Yes
No

Note: The CTS 3.0 system has the added capability of calibrating out any DC component on the input channels. This capability did not exist in CTS 1.X so no calibration coefficients are converted for DC offset. The CTS 3.0 will assume a 0 DC offset. If there is any concern about DC offset, a DC offset calibration can be performed if needed.

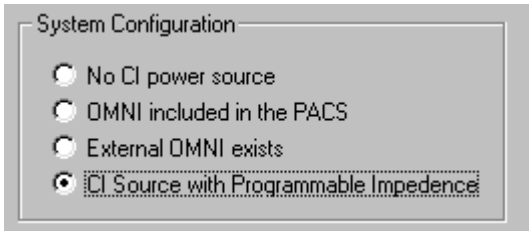
3.12.2 Checking Configuration Settings

Once the new software has been installed, it is important to check the configuration settings for the flicker reference impedance. This can be done by running the Configuration program located in the Compliance Test System program group.

Start the configuration program. A user name and password entry box will appear. The user name is used to track changes made to the calibration and configuration data. To check the settings, no user name or password is needed. Click on the View/Update Calibration information button to display the current settings.



Check the selection of the System Configuration in the lower right hand corner. Make sure this selection reflects the actual impedance method used.



If the setting is incorrect, close the configuration screen and re-launch the configuration program. This time you will have to unlock the settings so you can make the relevant change. Enter your user name and the following password:

CAL_LOCK followed by the Enter Key.

You can now open the configuration screen again and change the flicker impedance setting to the correct one.

When done, close the screen to save the new settings.

4. Program Menus

4.1 About this Chapter

This chapter provides an overview of the CTS 3.0 program menus. You may read this chapter to familiarize yourself with the menus available in the program for harmonics and flicker testing or proceed directly to the relevant chapter for the test you want to run and use this chapter only as a reference.

4.2 Main Menus

Many of the CTS system capabilities are accessible through the menus located at the top of the main window. These menus are organized in the following groupings. Click on any menu to view the sub menu items.

MENU	DESCRIPTION
File	Open, close and save test setups and data files. Also allows printing of test reports
Edit	Used to cut and paste graphs to other Windows programs or edit the report header text.
View	Allows test setups or a list of all tests performed with the system to be displayed. A link to the California Instruments' web site is provided on this menu as well.
Options	Several run-time and replay settings can be controlled from this menu.
Test	Starts a new test, allows replay of a previously recorded test, or display harmonics information of the most recent test.
Help	On line help and Program information.

Note: When a test is in progress, the menus are not available until after the test is completed. This prevents the test from being suspended while the user pulls down a menu, which is a unavoidable Windows issues.

4.3 File Menu

The File menu offers the following sub-menu choices.

SUB MENU	DESCRIPTION
New Test	Clears all data and brings up the test setup screen to start a new harmonics or flicker test.
Open Data File	Opens a previously recorded data file from disk. The data file can be either created on this computer or created on another computer.
Open Setup File	Opens a setup file. This allows a new test to be run with the exact same setup parameters. The setup file can either be created through “Save Test Setup” menu action or extracted from an existing test data.

SUB MENU	DESCRIPTION
Save Test Setup	Saves only the setup information in effect. The setup file name depends on the setup. For example, a steady state Class D test would have a name of Steady_D.cts_setup.
Save Test Data	Saves all data from the most recent test run. A test must be run first with data saving enabled. When data saving is enabled, a test will produce a binary file H-xxxxxx.cts_data (harmonics) or F-xxxxxx.cts_data (Flicker) where xxxxxx is the test number. Save test data menu action actually make a copy of that binary file to the specified file name and location. The file name used will be the same as used for the previous save operation unless this is the first save after a test run. In that case, the user will be prompted for a file name.
Save Test Data As	Saves a copy of the most recent test run binary data to a new file name. The user will be prompted for a name to use.
Report	Generate data needed for a test report and if MS Word is installed on the PC used, allows producing/viewing/printing a test report in MS Word. The MS Word version supported is Word 9.0 (Word 2000). Older versions of MS Word may no longer work when upgrading to the latest CTS 3.0.XX software version. In that case, a newer version of MS Word may have to be installed.
Report Preview	Previewing a test report in MS Word. MS Word must be installed on the PC used.
Print Report	Printing a test report in MS Word. MS Word must be installed on the PC used.
Exit	Terminates and exits the CTS 3.0 program

4.4 Edit Menu

The Edit menu offers the following sub-menu choices.

SUB MENU	DESCRIPTION
Copy Top Graph	Copies a bitmap image of the top graph displayed to the Windows Clipboard. From there, it can be pasted into other Windows programs.
Copy Bottom Graph	Copies a bitmap image of the bottom graph displayed to the Windows Clipboard. From there, it can be pasted into other Windows programs.
Edit Header	The Header is printed at the top of each report page. This sub menu brings up a dialog box that allows the header to be edited. For testing on behalf of a third party, this feature allows the test lab name to be printed on each report page.

4.5 View Menu

The View menu offers the following sub-menu choices.

SUB MENU	DESCRIPTION
Test Setup	Brings up a overview of all selected test setting for the current test. This is a display window only and no fields can be changed in this mode. To change setup option, close the active test window and select Perform a new Test from the Test menu.
Test List	Brings up a display grid showing all tests ran to date on the test system PC. For each test, a time stamp, test type and pass fail result is shown. Any test for which data was recorded can be played back by selecting it and clicking on the replay button at the bottom of the screen.
Calibration Info	Displays a summary window of the Card serial number, PACS serial number, frequency calibration and last calibration date.

4.6 Options Menu

The Options menu offers the following sub-menu choices.

SUB MENU	DESCRIPTION	
Get a new reference for each test	For Harmonics tests with a limit set that is a function of the power level or current of the EUT, a new reference can be established for each test run. Alternatively, the last used reference can be preserved for subsequent test. This menu entry toggle between these two available modes.	
Generate ASCII Files at the end of test	When selected, this option causes tab delimited ASCII files to be generated at the end of the test from the binary data files recorded during the test run. ASCII files take up more space but can be opened using other application programs. All the ASCII files will be in the sub directory “ASCII_files”. Please note that even if this item is not selected, conversion from a binary test file to ASCII files can also be accomplished using the ASCII converter program (Convert data to ASCII) supplied as part of the CTS 3.0 program suite.	
Show Banner at the end of test	When selected, this option causes a large banner (Green when PASS, Red when FAIL) to appear on the screen of the PC. This banner can be seen from across the room to notify a lab operator that the test run has been completed.	
Recall Type	Valid for data replay only. This option offers four choices for playback of data. Data is stored in acquisition windows or buffers. For Harmonics, acquisition windows are either 10, 12 or 16 cycles. For Flicker, acquisition windows are 1 second. Available recall choices are:	
	Every Window:	Every acquisition window is shown
	Every failed/distorted Window	Only acquisition windows with current failure or distorted source are shown.
	Every Failed Source Window	Only acquisition windows with high AC source distortion are shown.

SUB MENU	DESCRIPTION	
	Every Failed Current Window	Only acquisition windows with current failure are shown.
Recall Size	Amount of acquisition buffers or windows to be loaded from disk to memory during playback. The more windows are loaded, the further the user can back up in the data stream during playback. Thus, when selecting 100 buffers, the replay can be stopped and reversed up to 100 buffers. The recall size ranges from 0 to 1000 buffers.	
Replay Delay	Selects the time to wait between display data buffers during replay mode. On a fast PC, it may be useful to increase this time or the replay will run by too fast to see anything meaningful. Available delay times between buffers are 0.0 seconds for the fastest speed to 5.0 seconds for the slowest speed.	
Display Rate	This setting determines how many buffers are skipped for display purposes. While all data buffers are read from disk, only the selected buffer interval set here is displayed in the graphs. Available rates range from Every Acquisition to All the way to the End. The last setting means the data is read from disk all at once and only the last buffer is displayed at the end of replay. The user can then back up (recall) using the VCR style keys in the lower left corner of the screen.	

4.7 Test Menu

The Test menu offers the following sub-menu choices.

SUB MENU	DESCRIPTION
Perform a new test	Clears the existing test data from memory and brings up the test setup screen for both Harmonics and Flicker test.
Replay an existing test	Brings up the list of tests that can be replayed.
Select a test setup from Test List	Allows test setup information from any test in the test list to be copied to a new test setup.
Edit/View Fixed references	Allows editing of power level or current for test limits that are a function of EUT power and or EUT current. See Get new reference entry under Options menu.
Current Harmonics	Displays a table with current harmonics data of the most recent test.
Voltage Harmonics	Displays a table with voltage harmonics data of the most recent test.
Parameters Data	Displays a table with parameters of the most recent test.

5. Harmonics Testing

5.1 About This Chapter

This chapters covers testing a device for compliance with the IEC 61000-3-2 Harmonics standard. A review of the possible EUT classes is provided to assist the user in determining the appropriate device class to use. Once the device class has been established, the appropriate test module is used to perform the tests.

5.2 Test Standard Selection

Before running any Harmonics test, you must decide if you want to test to the old harmonics standard (IEC 61000-3-2:1998, includes Amendments 1 and 2) or the new one. (IEC 61000-3-2:2000, Amendment 14). Both may be used up to January 2004 after which time only the new standard should be used. The standard selection is made in the lower right hand corner of the setup screen. Once selected, some options may be grayed out. For example, the new test standard only considers transitory harmonics so the quasi-stationary selection is disabled. Note that the acquisition window over which the evaluation of current harmonics is made differs under both standards. Per the IEC 61000-4-7 referenced in Amendment 14, which replaces the Annex B of the 1998 standard, the evaluation window for Amendment 14 is 10 cycles at 50 Hz or 12 cycles at 60 Hz. The 1998 standard is based on an evaluation window of 16 cycles for 50 Hz. (same 16 cycles is used when the frequency is set to 60 Hz). Selecting the desired test standard automatically configures the CTS for the correct acquisition window.

5.3 Device Classes

The IEC 61000-3-2 categorizes products in one of four product classes. Using the correct class is important as the harmonic current limits for each class are different. Choosing the wrong class can mean rejecting a product that otherwise would have passed (False Negative) or passing a product that normally would have failed (False Positive). Either outcome is undesirable.

The following device classes are defined:

Class A All motor driven equipment, most “domestic” appliances and virtually all 3 phase equipment (<16 A rms per phase).

Class B All portable electric tools.

Class C All lighting products, including dimmers, with an active input power above 25 Watts.

Class D Products having a power range from 75 to 600 Watts AND a current waveform that has a special wave shape. For testing to IEC 61000-3-2:2000, Amendement 14, the special waveshape does not apply and only TV's PC's and PC Monitors with power levels between 75 and 600 W are considered class D. All other products are class A.

5.3.1 Class D Special Current Waveshape

If you elected to test to the IEC 61000-3-2:1998 standard, a unit is considered to be class D equipment if it meets the power consumption limits listed above and its current waveform matches at least 95 % of a specified wave shape template. This template is aimed at 'capturing' high crest factor loads that are known to generate high harmonic currents. The wave shape template consists of three time domain sections, one for each 1/3 period of the signal during a positive or negative half-cycle of the input voltage. The center section is normalized to, and centered around the peak current value. The other two sections have a 0.35 times Ipeak amplitude limit. The actual template is shown in Figure 5-1.

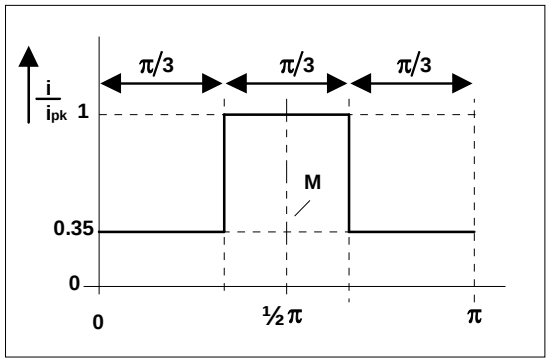


Figure 5-1: Class D Current Wave Shape Template

The exact IEC 61000-3-2:1998 standard text is as follows:

"..equipment shall be deemed to be Class D if, under the test conditions given in Annex C, the input current waveshape of each half period - referred to its peak value i_{pk} - is within the envelope shown in the following figure for at least 95 % of the duration of each half period; this implies that waveforms having small peaks outside the envelope are considered to fall within the envelope. The center line M, coincides with the peak value of the input current."

A device that does not meet these class D requirements defaults to a class A device and should be tested against the class A limits.

The flowchart shown in Figure 5-2 can be used to determine the class of the device to be tested.

When selecting IEC 61000-3-2:1998 mode with a Class D device, the CTS Software will display the current waveshape and the special waveform template. The percentage that fails within the template is displayed as well. If the waveform is not class D, the user will be given an indication. The test can still be run however. In Class A testing, the special waveform check is also performed to prevent a "False Positive".

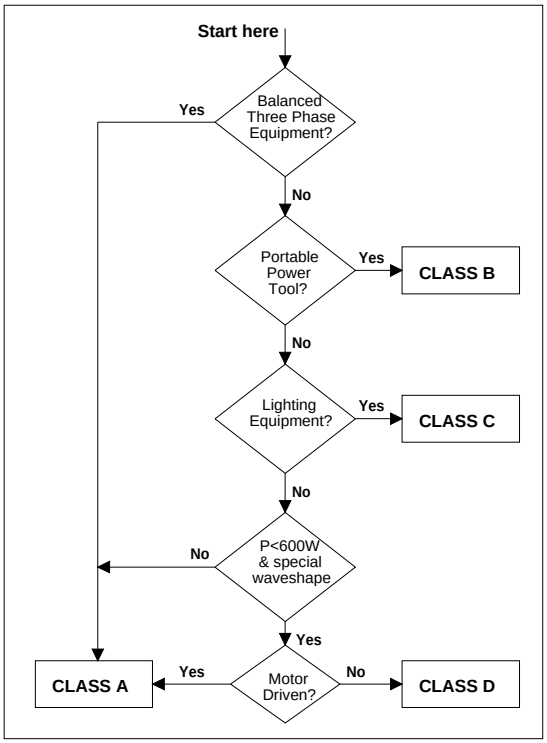


Figure 5-2: EUT Class Determination Flowchart

If the CTS software indicates that the current waveform does not meet the Class D requirements, the user should switch to Class A instead.

5.3.2 Dynamic Class C and D Limits

Harmonic current limits for Class D are a function of the EUT power level. This poses an interesting problem, especially if the device has a fluctuating power draw pattern. This means the test limits change with the power consumption of the EUT. While there is some discussion in the IEC community regarding the practicality of using such dynamic test limits, the CTS software is fast enough to dynamically recalculate the test limits applied to the current harmonics for each acquisition window of 16 signal periods. As such, the CTS system fully implements the IEC standard with respect to class D.

The same issue applies to the third harmonic limit for Class C products, which is a function of the fundamental current and power factor (λ). The CTS software determines the fundamental current and power factor of the load for each acquisition window and dynamically determines the correct 3^{rd} harmonic current limit for Class C devices.

If you select to test to Amendment 14, you will have to enter the manufacturer rated power for Class D (TV's, PC's and PC Monitors) or the fundamental current and power factor for Class C (lighting products) instead. The rated values will be used to calculate the Class C and D limits as long as the actual measured values do not differ from the rated values by more than 10 % during the test.

5.4 Stationary or Transitory Harmonics Test

The older IEC 61000-3-2:1998 standard distinguished between two types of tests, stationary for equipment that exhibits constant power consumption and transitory for equipment that exhibits fluctuating power consumption patterns.

Under the revised 2004 test standards, all tests are done by evaluating transitory harmonics so this selection is not longer relevant. Evaluation of current harmonics is always done using the transitory method so no user selection is provided. See section 2.3.3 for details on selecting the correct test time.

It should be noted that the user must ensure that the total test time applied is sufficient to cover a complete operating cycle of the EUT. Many devices are stationary in nature but notable exceptions exist. For example, a laser printer that periodically draws higher currents to heat the fuser may exhibit fluctuating harmonics and may require a test time that is sufficiently long to cover such an event. The same applies to microwave cookers and washing machines.

5.5 Running a Harmonics Test

Starting the CTS 3.0 main program brings up the test setup screen. This CTS 3.0 main program window automatically sizes to a SVGA display resolution of 800 x 600 pixels. Larger screen resolutions are supported but the controls on the main window will not size to any resolution above 800 x 600.

For correct harmonics and flicker measurement operation, please note the following setup guidelines:

1. **Make sure that the PACS and PC are operated from the same supply line.**
2. **Make sure that the power source is operated from the same basic supply circuit as the PC and PACS unit.**

A harmonics test is always started by setting the desired type and EUT class. Other settings involve the desired nominal voltage and frequency and test window size. The figure below shows the typical settings for a class A test.

Please note the six fields at the bottom of the set up screen are grouped as Default user input. The values you entered in these fields are not necessarily for the particular test you are about to perform. When you click OK, you will be presented with a measurement screen where you can enter similar information that is specific for the test. The Default User Input here is intended to facilitate the situations where a group of tests are to be performed where the information in Default User Input are applicable to all the tests in the group.

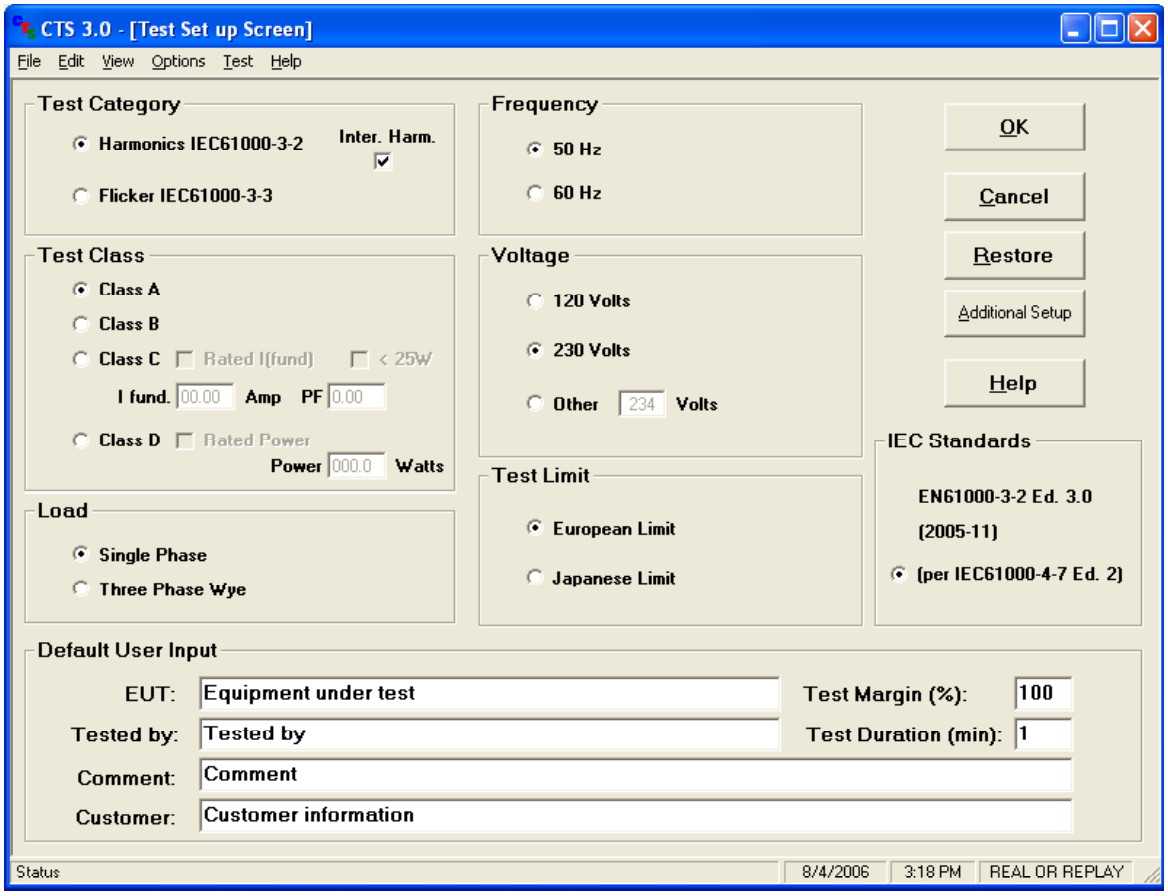


Figure 5-3: Typical Class A test setup

Note: If both the CTS 3.0 program and the CIGui32 or CIGuiSII are configured to use the same Com port or IEEE-488 bus controller to control the AC source, it is important that both programs not be active at the same time. Having both programs open at the same time could cause an interface conflict.

The following checklist shows all available setup options for a Harmonics test.

Field	Description / Purpose
Test Type	Select between Harmonics and Flicker test. If you select Harmonics test, you can also enable or disable inter harmonics evaluation. With the pending new revision of IEC 61000-4-7, current inter-harmonics have to be evaluation in addition to the harmonics.
Frequency	Choose 50 Hz or 60 Hz. This choice will be used to program the AC source output frequency. If no AC source is available or the AC source control option has not been selected, the measured frequency is checked against the user setting and an error message is generated if a discrepancy is detected. For IEC compliance testing, 50 Hz should be selected.
Test Class	Select the appropriate test class for the equipment under test. See paragraph 2.4.1 for test class selection.
Voltage	Select the correct line voltage. Default choices are 115 and 230 V RMS Line to neutral. A user-defined value may be entered by selecting the "Other" option. This setting is used to program the AC power source output voltage. If no AC source is available or the AC source control setting in the advanced setup screen has not been selected, the operator is responsible for ensuring the correct line voltage is applied to the EUT.
Load	Selects single or three phase mode. On single-phase CTS systems, the three phase selection is not available. For three-phase CTS systems, a wye connection to the PACS-3 must be used.
Test Limit	The CTS 3.0 retains a database of harmonic current test limits. This setting selects the limit set to use. Available options are European and Japanese. For normal IEC testing, the European option should be selected.
IEC Standards	This option may be used to select the inclusion of Amendment 14 which includes the evaluation of inter harmonics. Harmonics are always evaluated over 10 periods at 50 Hz and 12 periods at 60 Hz for a 200 msec at either line frequency.
EUT	This field may be used to enter information about the equipment under test. This field is used to hold a default value.
Tested by	This field may be used to enter operator information. This field is used to hold a default value.
Comment	Comment field for general use. This field is used to hold a default value.
Customer	If the test is performed on behalf of a third party, information about the entity for which the test is performed may be entered here. This field is used to hold a default value.
Test Margin	Determines at what scale factor the harmonic test limits will be applied. For most situations, this value should be set to 100 %. If testing is done for pre-compliance, setting a lower margin will provide an extra margin of safety against system tolerances of different test systems. This field is used to hold a default value.
Test Duration	Enter the total test time. For Steady State Harmonics, the default test time is 1.0 minute. For Transitory Harmonics, the default test time is 2.5 minutes. For flicker tests, the default time is 10 minutes. Maximum test time is 1440 minutes or 24 hours. This field is used to hold a default value.

Table 5-1 : IEC Harmonics Setup Parameters

5.6 Additional Setup Parameters for Harmonics

If this is first time using the CTS 3.0 system, it may be necessary to check the Additional Setup settings. These settings can be displayed by clicking on the "Additional Setup" button on the right hand side of the main setup window.

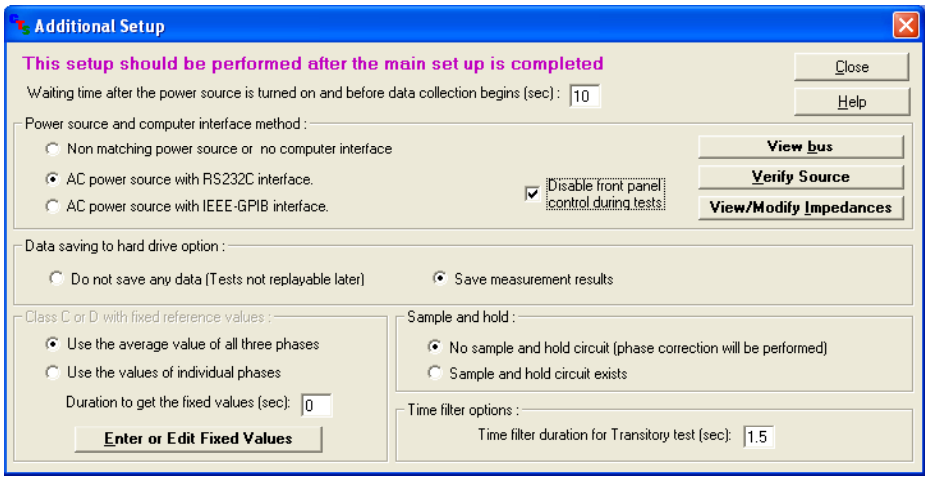

Additional Setup
This setup should be performed after the main set up is completed
Close
Help
Waiting time after the power source is turned on and before data collection begins (sec) : 10
Power source and computer interface method :
Non matching power source or no computer interface
AC power source with RS232C interface.
AC power source with IEEE-GPIB interface.
Disable front panel control during tests
View bus
Verify Source
View/Modify Impedances
Data saving to hard drive option :
Do not save any data (Tests not replayable later)
Save measurement results
Class C or D with fixed reference values :
Use the average value of all three phases
Use the values of individual phases
Duration to get the fixed values (sec): 0
Enter or Edit Fixed Values
Sample and hold :
No sample and hold circuit (phase correction will be performed)
Sample and hold circuit exists
Time filter options :
Time filter duration for Transitory test (sec): 1.5

Figure 5-4: Additonal Settings for Harmonics Test

The following settings are available from this dialog window:

Setting	Description	
Pre test time	This is the time during which to apply power to the EUT before staring the harmonics measurements. This capability may be used to skip any startup behavior of the EUT that may affect the outcome of the test. High EUT inrush currents that exceed the AC Source's maximum peak current capability can result in high voltage distortion. This would invalidate the test. The Pre-test time setting can be used to hold off measurements until after the EUT has reached a steady state condition.	
Source Control	The CTS system is normally supplied with a suitable AC power source to provide stable and low distortion AC power to the EUT. The Source Control section of the additional setup dialog is used to configure the CTS system for the AC Source used. Available options are:	
	Use the AC source from its front panel only	This option may be needed if the AC Line is used or the AC source used does not offer remote control capabilities. This way of operating puts more responsibility on the operator to ensure the correct power is applied during the test.
	RS232C control	Used with AC Sources that have RS232C control capability. The Verify Source must be used to make sure the AC Source can be found. The AC source must be connected using the serial cable provided and must be powered up. The View Bus button may be used to bring up the command trace for trouble shooting purposes if the presence of source cannot be verified. When using remote control, the user can select to have the front panel locked or not by setting the Disable checkbox. Note that support for the Pacific Power Source AMX with -

Setting	Description	
		1UP or -3UP controllers is provided as well.
	IEEE-488 control	This selection requires the presence of a National Instruments IEEE-488 controller card or compatible card in the PC. This interface is not supplied as part of the CTS system but may be added as an option. The Verify Source must be used to make sure the AC Source can be found. The AC source must be powered up. The View Bus button may be used to bring up the command trace for trouble shooting purposes if the presence of source cannot be verified. When using remote control, the user can select to have the front panel locked or not by setting the Disable checkbox. Note that support for the Pacific Power Source AMX with -1UP or -3UP controllers is provided as well.
Test Data	Test data for each test can be saved to disk for later replay or report generation. If this option is not selected, the test cannot be replayed later or printed. For most situations, it is recommended to save the test data. For debugging sessions, it may be acceptable to turn off this option to preserve disk space.	
Class C and D Test Limits	Test limits for class C and D are not fixed but rather depend on the EUT power level and or power factor. The CTS 3.0 uses the generally accepted dynamic test limit calculation method to determine the correct limits for each acquisition window. Using the settings in this frame however, the operator may override this implementation and set a fixed limit for Class D and C. The time for which to acquire power and or power factor data from the EUT can be set in the Duration field in seconds. For three-phase mode, the power can be averaged over all three phases.	
Sample and Hold	This option allows CTS systems with and without sample and hold circuitry to be used. In the absence of a S/H circuit, the CTS 3.0 software will perform phase correction between voltage and current channels.	
Time filter duration for transitory harmonics filtering.	This value should be set for 1.5 seconds to comply with the IEC 61000-3-2 standard. Future standard changes may require this value to be changed.	

Table 5-2 : IEC Harmonics Advanced Setup Parameters

5.7 Main Harmonics Test Window Operation

Upon closing the Main setup window, the harmonics test window will appear. Tests are executed from this window and test results are displayed in real-time. This main harmonics test window has a limited number of controls, the function of which are explained in the table below.

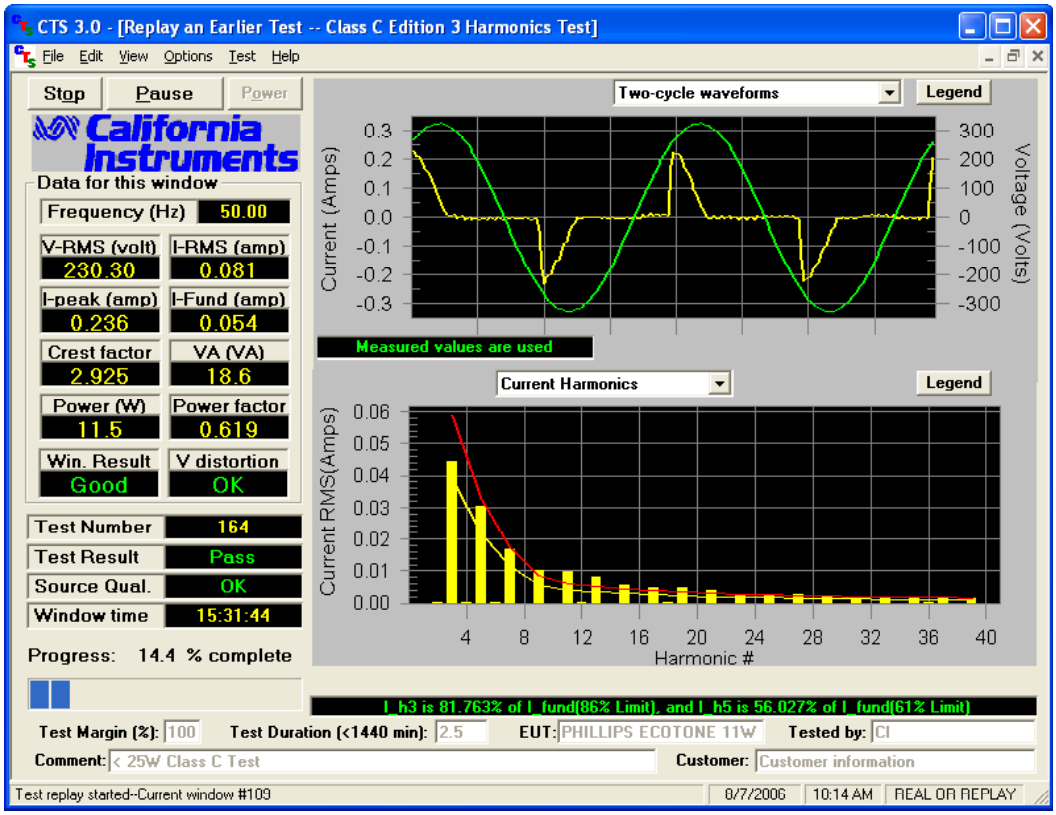


Figure 5-5: Harmonics Test Window

Field / Control	Location	Description
Start button	Upper left corner	Starts harmonics test using presently selected parameters. Once a test is running, parameters cannot be changed. Starting a test also causes data to be written to the test data file if data recorded is enabled. Each time a test is run, a new sequential 'Test Number' is assigned. Results for each test are automatically logged. Data for each test is only recorded if this option is selected in the Additional Setup screen. Once a test is running, the Start button changes to a Stop button. Also, any menus will be disabled while a test is in progress as pulling down a menu under Windows will cause the application to halt which would result in data loss.
Stop button	Upper left corner	Stop the acquisition process. The Stop button can be used to abort a test prematurely. The data files will be closed and will only contain data up to the point at which the test was aborted. Test log will indicate if the test completed normally or was aborted by the user.

Field / Control	Location	Description
Report button	Upper left corner	The Print Summary button generates a test report in an MS Word doc file. This report contains both the voltage and current waveform and the harmonics display graph. It also includes the current and voltage harmonics in absolute values and as a percentage of the applied IEC limits.
Power Buttons	Upper left corner	These button controls may be used to turn the AC power source output on or off. The configuration can be set to use automatic power on/off, automatic on / manual off or manual on and off control of the AC source. If no AC source control option is selected, the operator has to use the front panel of the AC source instead and this button will not be available. In manual mode, the operator must click on the Power On button to turn on power to the EUT.
WINDOW	**DATA**	The data in the Window Data frame on the left side of the main harmonics screen applies to successive acquisition buffers. Acquisition buffers are 320 ms for 50 Hz EUT's and 266.67 ms for 60 Hz EUT's if the 16 Cycle window size is selected. If the 10/12 cycle window size is selected, the buffer size is 200 msec.
Frequency - Hz	Left panel	Displays the AC signal frequency in Hz. If the frequency is not 50 or 60 HZ, "F???" will appear in the field of VTHD and Source Qual. The test will continue however but the results may not be valid.
Voltage - RMS	Left panel	Displays the Root Mean Square voltage of the AC source output for each acquisition buffer.
Current - RMS	Left panel	Displays the Root Mean Square current to the EUT for each acquisition window.
I peak	Left panel	Displays the peak current value of the EUT current. If the EUT produces no harmonic currents, the peak current is $\sqrt{2}$ times the RMS current.
I Fund	Left panel	Displays the value of the fundamental current of the EUT for each acquisition window. The fundamental current is the current at 50 Hz or 60 Hz only, without any contributions from higher order harmonic currents. If the EUT produces no harmonic currents, the fundamental current will be the same as the rms current.
Crest Factor	Left panel	Displays the crest factor of the EUT current. Crest factor is the ratio between the peak current and the RMS current.
VA Power	Left panel	Displays the apparent power consumption of the EUT for each acquisition window.
Power - Watts	Left panel	Displays the real power consumption of the EUT for each acquisition window.
Power Factor	Left panel	Displays the ratio between real power and VA power of the EUT for each acquisition window.
Window Result	Left panel	Indicates if the present acquisition buffer current harmonics exceed the selected EUT current limits. If one or more acquisition buffers report a failure, the overall test result will fail. This field will typically toggle between good and fail during the test run.
VTHD	Left panel	Indicates if the present acquisition buffer has a voltage distortion that exceeds the IEC limit.
Test Number	Bottom Left	Each test run is assigned a sequential test number. The number for the current test is displayed in this field. This allows individual test results to be tracked.
Test Result	Bottom Left	This field provides a visual indication of the test result. A Green field with Pass indicates the EUT current harmonics are below the limit, a Red field with Fail indicates the EUT current harmonics are above the limit. Note that the condition of this field is affected by the user selected test margin. To use the actual IEC test limits, the test margin should be

Field / Control	Location	Description
		set to 100 %. This field depends on the "Window results" of all the windows up to this test time and if any "Window result" is failed during a test, Test result will be "Fail". In other words, this field is "Fail" latching.
Source Qualification	Bottom Left	This field displays overall AC Source voltage distortion status for the test so far. At the end of the test, this field indicates if the AC Source failed the voltage distortion test at any time during the test. The VTHD indication is given to notify the user of a possible problem with the AC source voltage distortion, which may invalidate the test results. The test will not be aborted however if the voltage distortion is too high.
Start Time	Bottom Left	This field always shows the start time of the test in progress. The test duration is shown in the bottom panel. See also the "% of test completed" indication and the progress bar below the Start Time field.
% of test completed	Left panel	During test execution, this field displays the percentage of the test that has been completed. Once this number reaches 100 %, the test will terminate normally. If the user clicks on the Stop button instead, it will display the point at which the test was aborted.
Test Margin	Bottom	The test margin can be set by the user if a pre-compliance test is needed and the user wants to set more stringent limits. The test margin number defaults to 100 % to use the exact IEC limits. A lower percentage will means the EUT has to pass lower test limits (more stringent). The value of this field ranges from 50 % to 150 %. Note that the limit lines in the Graph always display the 100 % IEC limits. The test margin is only used for Pass or Fail determination.
Test Duration	Bottom	The test duration is the total test time selected by the user. This value can be set from 0 to 1440 minutes (24 hours). This value should be set before starting the test as it cannot be changed while a test is in progress. If the duration is 0 minutes, then only one window will be acquired.
EUT	Bottom	This field can be used to enter information about the unit under test. The EUT field contents will be included in the test data file and in any reports that are printed.
Comments	Bottom	This field can be used to enter any information about the test. The Comments field contents will be included in the test data file and in any reports that are printed.
Tested by	Bottom	This field can be used to enter information about the operator. The "Tested by" field contents will be included in the test data file and in any reports that are printed.
Customer		This field can be used to enter information on a customer if you are running tests for a third party. The "Customer" field contents will be included in the test data file and in any reports that are printed.
Voltage and Current Graph	Top right panel	This graph displays the AC voltage and current waveforms. At all times, two periods of the AC signal are displayed. The voltage is shown in yellow, the current in green. For Class D tests, the special waveshape template is displayed in the same graph using red. The percentage of the EUT current outside the template is shown directly below the graph.
Harmonics Graph	Bottom right panel	The Harmonics graph panel can be used to display the current harmonics (green) and test limits (red) during the test. It is also possible to toggle this display to show the AC voltage harmonics. The drop down control located at the top of the Harmonics graph panel can be used to select alternate display modes.
Legend buttons	Graph panels	The Legend buttons can be used to display a pop-up window that shows the color coding used in each graph.

5.7.1 Entering User and/or Customer Data

Prior to running a test, you should enter information concerning the EUT, the person or department performing the test and any other information that may be relevant to interpreting or using the test results obtained from the CTS system. Several fields are provided for this purpose along the bottom of the main test window. If the test is performed on behalf of a third party, the customer data field may be used to document the customer name.

The information entered in these fields is added to the test data file and any reports that are printed. The date and time of the test run are automatically added based on the PC's real-time clock.

5.7.2 Selecting the Test Period

The test period should be set appropriately for the test mode selected and the EUT at hand. For details on setting the correct harmonics test time, refer to paragraph **Error! Reference source not found.** for IEC 61000-3-2:1998 mode or paragraph 2.3.3 for IEC 61000-3-2:2000 mode. For flicker tests, the default is 10 minutes. You can increase the test time up to 24 hours if needed.

5.7.3 Setting the Test Margin

The CTS system offers the user the choice of setting a test margin around the IEC limits. This means a user specified factor can be applied to the IEC test limits. The default value used is 100 % which essentially means the actual IEC limits are applied to determine a pass or fail result. This is the mode to use for actual compliance testing.

Setting this margin to a value below 100 % can be useful for pre-compliance testing. Selecting a lower margin means the test is more stringent. If the EUT can pass the more stringent test, it is more than likely to pass when submitted to an independent test lab. Setting the margin above 100 % means you are "loosening" the limits allowing EUT's to pass that would normally fail. This mode is not recommended.

5.8 Running the Harmonics Test

Before starting a test, make sure all user fields are set correctly. Changes to these fields are no longer possible once a test is in progress. Also make sure the EUT is connected to the AC output of the PACS unit and the correct AC line voltage is programmed on the AC source.

A test run is started by clicking on the Start button. During test execution, the "% of test completed" field on the left of the main window displays the percentage of the test that has been completed. Once this number reaches 100 %, the test will terminate normally. If you click on the Stop button instead, it will display the point at which the test was aborted.

During the test execution, the CTS 3.0 software will continuously evaluate the EUT current harmonics against the appropriate class limits. The Pass or Fail indication is updated in real-time. If the test fails early in a long test period, you may elect to abort the test prematurely rather than waiting till the end.

5.8.1 Voltage and Current Waveform Graphs

The top graph continuously displays two signal periods of the AC voltage (yellow) and current (green) waveforms. For Classes A and D tests, it also shows the special current wave shape template in red. Alternate display modes can be selected from the drop down combo at the top of the graph.

5.8.2 Voltage and Current Harmonics Graphs

The bottom graph serves a dual purpose. During the test run, it can be used to show either the current or the voltage harmonics. In either mode, the IEC test limits are displayed using a red line for the current harmonic limits and a green line for the voltage harmonic limits.

Note: The voltage harmonic limits apply to the AC source qualification and may indicate that the current harmonics are affected due to excessive AC voltage distortion. In this case, a red Source Qual. label is shown on the left hand side of the main window.

When displaying the current harmonics, the actual harmonic currents from the second through the fortieth for each acquisition window are shown in green. The IEC test limits are shown using a red line. Note that this red line always displays the 100 % IEC test limits during Steady State testing, regardless of the user specified test margin which is used for the Pass or Fail determination. (see "Setting the Test Margin" , found in paragraph **Error! Reference source not found.**).

Note: The fundamental current is not shown in the harmonics graphs as there is no test limit for the fundamental.

5.8.3 Aborting a Test

Tests in progress can be aborted at any time by clicking on the Stop button. Aborted test data files will be marked as incomplete.

5.9 Printing Results

The Report button allows you to print both on-screen graphs displays and current and voltage harmonics test result data to an MS Word document. This provides a test report that displays the test setup, the Pass or Fail result and a graph of the voltage and current waveform as well as the worst case values for each of the current harmonics. The Report button is available at the end of a test run or any time a test is aborted with the Stop button.

Note: The MS Word version supported is Word 9.0 (Word 2000). Older versions of MS Word may no longer work when upgrading to the latest CTS 3.0.XX software version. In that case, a newer version of MS Word may have to be installed.

5.10 Harmonics Test Data Files

The CTS 3.0 Software can be configured to log test data to a file. The file format used is proprietary but can be converted at the end of the test to an ASCII text file with tab delimited fields for voltage, current, power, peak current and all the current harmonics. This data is recorded in real-time or three to four times a second.

Longer test times will result in larger test data files and reports. If you increase the test time, make sure you have sufficient hard disk space available to accommodate these long test files. The rate at which data is written to disk can be decreased to avoid excessive file sizes. The point at which the program will reduce the rate of data storage can be set in the configuration. Should a test failure occur while the CTS 3.0 program is in this reduced data rate recording mode, full rate data recording resumes for a specified number of acquisition buffers. This always provides detailed information around the time of the failure. These recording rate settings can be set in the miscellaneous section of the configuration program.

5.11 Three Phase Testing

Three phase testing is similar to single phase testing described above except that three line voltages and three line currents are being measured simultaneously and displayed in the CTS 3.0 software GUI.

The three phase mode screens are virtually identical in function and form to the single-phase screens. The user can view one phase at a time, or all three phases simultaneously.

5.12 Replay Mode

The CTS 3.0 Software can be used to replay previously recorded test data. This replay can be done on the same test system that was used to record the original data or on an altogether different PC.

In order to replay a test, the data acquired during the test needs to be saved to a CTS native data file. If the save data option is not enabled in the additional setup window for Harmonics, there is no way to replay a test later. The Pass or Fail result of any run on the actual test system PC is always logged however. If a different PC is used to play back data, the data files have to be transferred to this PC first. The test data files are stored in the following directory:

C:\Program Files\California Instruments\CTS\Data_files

5.12.1 To play back test on the actual test system PC, proceed as follows:

1. From the Test Menu, select 'Replay an existing test'. This will bring up a table showing all tests ever run on this system.
2. Select the test you want to replay by clicking on its row. If data for this test was stored and is available, the Replay Test button at the bottom will be enabled.
3. Click on the Replay Test button to start the replay process. This will bring up a standard Harmonics or Flicker test screen.
4. To start the replay process, click on the Start button. The data displayed will be taken from the stored data files. The replay mode is indicated in the lower right corner on the status bar.
5. The buffer rate and speed at which data is replayed can be controlled using the various settings in the Options menu. This may be required to adjust to the speed of the PC used.
6. The replay process can be halted at any time by clicking on the Stop button. This will stop the data at the buffer number shown in the lower left corner.
7. Once stopped, the data can be stepped forward or backward at various rates using the VCR style buttons in the lower left corner.
8. A test report can be printed from stored data in this mode. The actual date and time the data was recorded will be shown on the report in addition the report print date and time.

5.12.2 To play back test on a different PC from the test system PC, proceed as follows:

1. If not already done, install a copy of the CTS 3.0 software on the other PC. When launched, the absence of a data acquisition system will be detected and flagged. This is normal.
2. Transfer the data files to the PC used for replay, either using a network connection or disk.
3. From the File menu, select the Open Data File entry, This brings up the standard file open dialog box.
4. Locate and select the file to be replayed. Harmonics files start with the letter H, flicker files start with the letter F.
5. Click on the Open button to open the test data file. This will bring up the test window.
6. To start the replay process, click on the Start button. The data displayed will be taken from the stored data files. The replay mode is indicated in the title of the CTS software.
7. The buffer rate and speed at which data is replayed can be controlled using the various settings in the Options menu. This may be required to adjust to the speed of the PC used.
8. The replay process can be halted at any time by clicking on the Stop button. This will stop the data at the buffer number shown in the lower left corner.

9. Once stopped, the data can be stepped forward or backward at various rates using the VCR style buttons in the lower left corner.
10. A test report can be printed from stored data in this mode. The actual date and time the data was recorded will be shown on the report in addition the report print date and time.

5.12.3 Harmonics Replay Options

Data replay capability is an important diagnostic feature of the CTS 3.0 system. The end user has a great deal of control over the replay process. These user settings are located in the Options menu. The following options are available to control the replay process:

Menu Item	Description	
Recall Type	This option offers four choices for playback of data. Data is stored in acquisition windows or buffers. For Harmonics, acquisition windows are either 10, 12 or 16 cycles. For Flicker, acquisition windows are 1 second each. Available recall choices are:	
	Every Window:	Every acquisition window is shown
	Every failed/distorted Window	Only acquisition windows with one or more failures are shown.
	Every Failed Source Window	Only acquisition windows with high AC source distortion are shown.
	Every Failed Current Window	Only
Recall Size	Amount of acquisition buffers or windows to be loaded from disk to memory during playback. The more windows are loaded, the further the user can back up in the data stream during playback. Thus, when selecting 100 buffers, the replay can be stopped and reversed up to 100 buffers. The recall size ranges from 0 to 1000 buffers.	
Replay Delay	Selects the time to wait between display data buffers during replay mode. On a fast PC, it may be useful to increase this time or the replay will run by too fast to see anything meaningful. Available delay times between buffers are 0.0 seconds for the fastest speed to 5.0 seconds for the slowest speed. During delay, you can click on the pause button to pause.	
Display Rate	This setting determines how many buffers are skipped for display purposes. While all data buffers are read from disk, only the selected buffer interval set here is displayed in the graphs. Available rates range from Every Acquisition to All the way to the End. The last setting means the data is read from disk all at once and the last buffer is displayed right away. The user can then back up using the VCR style keys in the lower left corner of the screen.	

Table 5-3 : IEC Harmonics Replay Settings

6. Flicker Testing

6.1 About This Chapter

This chapter covers testing a device for compliance with the IEC 61000-3-3 Flicker standard. The relevant IEC Flicker test part is described in detail.

6.2 Principle of Operation

The CTS Flicker software acquires, stores, processes and analyzes the EUT data in real-time and provides continuous display updates on all Flicker parameters. Voltage time domain data is collected, the rms voltage value is calculated for each half period of the signal or every 10 mseconds, and the measurement data is written to disk for 100 consecutive acquisition periods or once every second.

This allows the operator to monitor the progress of the flicker test and, should a failure occur before the end of the test run, abort the test if needed. Since flicker test can run for several hours, this will avoid needless waiting for tests to finish on a EUT that already failed the IEC requirements.

In order to run the real-time Flicker test, you need a 2.0 GHz Pentium PC or better. This is caused by the amount of data that needs to be processed to perform flicker evaluation. Slower PC's will not be able to process the data in real-time.

6.3 Flicker Test Options

The CTS Flicker test mode supports several test modes. These modes allow the user to select the flicker parameters that shall be used to determine a PASS or FAIL result. Some types of EUT may not need to be evaluated for Plt since they are unlikely to cause long-term flicker. This is largely a function of the operating cycle of the equipment being evaluated. Consult Annex A of the IEC 61000-3-3 test standard to determine which test option is most appropriate for the EUT under evaluation. The following options are available

Mode	Description
Test all Flicker parameters	This is the default test mode and should be used if you are unsure about the typical operating cycle of the unit under test.
Test dc, dt, dmax and Pst only	This mode only tests for compliance to the dc and dt specifications.
Test dc, dt and dmax only	This mode only tests for short-term flicker. It can be used to test equipment that has operating cycles less than 2 hours. Several levels of dmax may be permissible depending on the EUT. The selection criteria are as follows: The maximum relative voltage change d max , shall not exceed a) 4 % without additional conditions; b) 6 % for equipment which is – switched manually, or – switched automatically more frequently than twice per

Mode	Description
	day, and also has either a delayed restart (the delay being not less than a few tens of seconds), or manual restart, after a power supply interruption. **NOTE:** The cycling frequency will be further limited by the Pst and Plt limit. For example: a dmax of 6 % producing a rectangular voltage change characteristic twice per hour will give a Plt of about 0,65. c) 7 % for equipment which is – attended whilst in use (for example: hair dryers, vacuum cleaners, kitchen equipment such as mixers, garden equipment such as lawn mowers, portable tools such as electric drills), or – switched on automatically, or is intended to be switched on manually, no more than twice per day, and also has either a delayed restart (the delay being not less than a few tens of seconds) or manual restart, after a power supply interruption. In the case of equipment having several separately controlled circuits in accordance with 6.6, limits b) and c) shall apply only if there is delayed or manual restart after a power supply interruption; for all equipment with automatic switching which is energized immediately on restoration of supply after a power supply interruption, limits a) shall apply; for all equipment with manual switching, limits b) or c) shall apply depending on the rate of switching.
Inrush Current and Dmax Test	It may be necessary to determine, by examination of the circuit diagram and specification of the equipment and by a short functional test, whether significant voltage fluctuations are likely to be produced. For voltage changes caused by manual switching, equipment is deemed to comply without further testing if the maximum r.m.s. input current (including inrush current) evaluated over each 10 ms half-period between zero-crossings does not exceed 20 A, and the supply current after inrush is within a variation band of 1,5 A. Select this option to perform this test.
24 x Dmax Test	Select this option to determine the Dmax test in accordance with Annex B of IEC 61000-3-3 Amendment 1. The program will guide the user through the required steps for taking 24 startup readings. The default current threshold for detecting an EUT is 500 mA. If the EUT draws less current than 500 mA in the on state, this threshold value may have to be lowered in the configuration screen.

6.4 Running a Flicker Test

Running a flicker test is similar to running a harmonics test. Launch CTS 3.0 and select flicker test in the set up screen. Then select appropriate test parameters and click OK to continue. You will be presented with a test screen similar to that of harmonics.

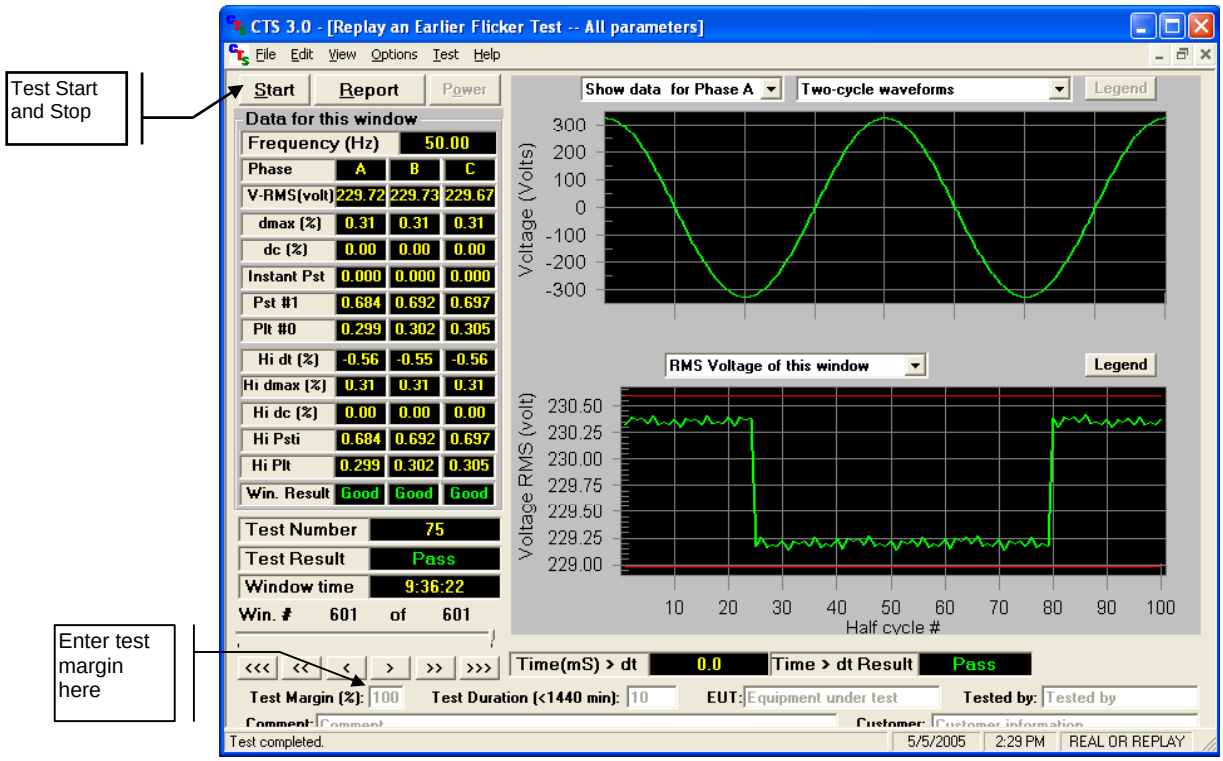


Figure 6-1: Flicker Test Window

The flicker test window has several user accessible fields and controls. The following table briefly describes the purpose of each field and control.

Field / Control	Location	Description
Power button	Upper left corner	Click on Power to toggle the power source output voltage, unless power source is already programmed to 230V. The Flicker module can be configured to turn off the power after every test, in that case therefore, the user will have to click Power On before starting the test.
Start button	Upper left corner	Starts the flicker test using presently selected parameters. Once a test is running, parameter cannot be changed. Starting a test also causes data to be written to the test data file.
Stop button	Upper left corner	Stop the acquisition process. The Stop button can be used to abort a test prematurely. The data files will be closed and will only contain data up to the point at which the test was aborted.
Report Button	Upper left corner	Used to produce a test report in WORD. A WORD must be installed to generate the report.
Power Button	Upper left corner	Can manually toggle the power on/off. A PC to power source communication is needed before it is enabled.
Frequency	Left Panel	Displays signal frequency
V-rms (volt)	Left Panel	Displays Voltage rms value
Test Start Time	Left panel	This field always shows the start time of the test in progress. The test duration is shown in the bottom panel.
Highest d_c %	Left panel	Displays the highest Relative Steady State voltage change (d_c) in % found so far during the test. This represents the difference between two adjacent steady-state voltages relative to the nominal voltage. The standard requires that d_c must be less than or equal to 3 % for the EUT to PASS.
Highest d_{max} %	Left panel	Displays the highest Maximum relative voltage change (d_{max}) in %. found so far during the test. This represents the difference between the maximum and minimum rms values of the voltage change characteristic relative to the nominal voltage. The standard requires that d_{max} must be less than or equal to 4 % for the EUT to PASS.
Highest d_t %	Left panel	Displays the highest Relative voltage change characteristic (d_t). This value represents the change in rms voltage, relative to the nominal voltage, as a function of time and between periods when the voltage is a steady state condition for at least 1 second. The standard requires that d_t must be less than 3 % for the EUT to PASS, although it is permitted to be between 3 and 4 % for less than 200 msec.
Highest Psti	Left panel	Displays the highest Short Term Flicker value found so far during the test. Each Short Term Flicker severity is evaluated over period of 10 minutes. The threshold of irritability is Pst = 1 and this value is used as the PASS/FAIL limit.
Highest Plt	Left panel	Displays the highest Long Term Flicker value (Plt) found so far during the test. The Plt period is 120 minutes and is calculated using successive Psti values. The threshold of irritability for long term flicker is 0.65 and this value is used as the PASS/FAIL limit.
Test Status	Center panel	This field provides a visual indication of the test result. A Green field with Pass indicates the EUT passes the Flicker test, a Red field with Fail indicates the EUT causes too much flicker. Note that

Field / Control	Location	Description
		the condition of this field is affected by the user selected test margin. To use the actual IEC test limits, the test margin should be set to 100 %.
Voltage - rms (Ut)	Center panel	Displays the Root Mean Square voltage of the AC source output for each acquisition window. Acquisition windows are 10 ms for 50 Hz EUT's and 8 ms for 60 Hz EUT's.
d_{max} %	Center panel	Displays the present Maximum relative voltage change (d_{max}) in %. This represents the difference between the maximum and minimum rms values of the voltage change characteristic relative to the nominal voltage. The standard requires that d_{max} must be less than or equal to 4 % for the EUT to PASS.
d_c in %	Center panel	Displays the present Relative Steady State voltage change (d_c) in %. This represents the difference between two adjacent steady-state voltages relative to the nominal voltage. The standard requires that d_c must be less than or equal to 3 % for the EUT to PASS.
Plt # n	Center panel	Displays the present Long Term Flicker value for Pst period number n. The Plt period is 120 minutes and is calculated using successive Psti values. The threshold of irritability for long term flicker is 0.65 and this value is used as the PASS/FAIL limit.
Instant. Pst	Center panel	Displays the instantaneous Short Term Flicker value. At the end of each 10 minute period, this value will be the Pst for the period.
Psti #n	Center panel	Displays the present Short Term Flicker value for period n. The Short Term Flicker severity is evaluated over a period of 10 minutes. The threshold of irritability is Pst = 1 and this value is used as the PASS/FAIL limit.
Select Test	Test selection	This combo box allows one of three test modes to be selected: • Test all Flicker parameters • Test dc and dt only • Test Pst only
Test Margin	Test Margin	This field allows the user to set the test margin from 50 % to 150 %. Additional information on setting a test margin is shown later in this chapter.
Graph Display	Graph panel	The graph panel is used to display either d_c and d_t or Ut rms as a function of time. The user can change display modes using the Graph mode drop down box located directly above the graph itself.
Graph mode	Display mode / Print panel	The Flicker module allows the user to toggle between two display modes. One mode shows the dc and dt as a function of time. The other mode shows the Ut rms value as a function of time. Each mode shows a time windows of about 2 seconds and is updated once every 2 seconds.
Test File	Bottom panel	This fields shows the currently selected test data file. It also provides a File button which can be used to change the selected test data file. The test data file is the file to which new data will be written while a test is running. Once a test is started, this button in disabled as the test data file cannot be changed while it is in use by the program. Note that the actual file name may be too long to fit in

Field / Control	Location	Description
		the space provided on screen. If this is the case, use the File button to display the file dialog box which will allow you to see the entire path and file name.
Test Duration	Bottom panel	The test duration is the total test time selected by the user. This value can be set from 0.5 minutes (30 seconds) to 1440 minutes (24 hours). Note that a Pst and/or All parameter test requires a test time of at least 10 minutes. The default test time is set to 10 minutes.
EUT	Bottom panel	This field can be used to enter information about the unit under test. The EUT field contents will be included in the test data file and in any reports that are printed.
Comments	Bottom panel	This field can be used to enter any information about the test. The Comments field contents will be included in the test data file and in any reports that are printed.
Tested by	Bottom panel	This field can be used to enter information about the operator. The "Tested by" field contents will be included in the test data file and in any reports that are printed.

6.4.1 Entering User Data

Prior to running a test, you should enter information concerning the EUT, the person or department performing the test and any other information that may be relevant to interpreting or using the test results obtained from the CTS system. Several fields are provided for this purpose along the bottom of the main test window.

The information entered in these fields is added to the test data file and any reports that are printed. The date and time of the test run is automatically added based on the PC's real-time clock.

6.4.2 Selecting the Test Period

The default test time for Flicker tests is 120 minutes which provides 12 short term flicker values of 10 minutes each. The user can set the test time anywhere from 0.5 minutes to 1440 minutes or up to 24 hours if needed. The test period needs to be set long enough to cover the entire operating cycle of the unit under test. If a test time less than 120 minutes is entered, the Plt will be evaluated using 12 Psti values and deeming the non measured 10-minute periods to have a zero Psti.

Equipment that is unlikely to produce long-term flicker based on its typical operating cycle need not be tested for Plt. This can significantly reduce the test time. If you are unsure however of the EUT's behavior, you are advised to perform a 2 hour test (120 minutes) to verify compliance with IEC 61000-3-3.

6.4.3 Test Data Files

The CTS 3.0 Software can save the flicker test waveform and result during the test if the saving option is enabled. The file will be saved in the data_files subdirectory. For test #25, the file will be F-000025.cts_data. This file can be replayed later with the same software.

6.4.4 Setting the Test Margin

The CTS system offers the user the choice of setting a test margin around the IEC limits. This means a user specified factor can be applied to the IEC test limits. The default value used is 100

% which essentially means the actual IEC limits are applied to determine a pass or fail result. This is the mode to use for actual compliance testing.

Setting this margin to a value below 100 % can be useful for pre-compliance testing. Selecting a lower margin means the test is more stringent. If the EUT can pass the more stringent test, it is more than likely to pass when submitted to an independent test lab.

Setting the margin above 100 % means you are “loosening” the limits allowing EUT’s to pass that would normally fail. This mode is not recommended.

6.4.5 Running the Flicker Test

Before starting a test, make sure all user fields are set correctly. Changes to these fields are no longer possible once a test is in progress. Also make sure the EUT is connected to the AC output of the PACS unit and the correct AC line voltage is programmed on the AC source.

A test run is started by clicking on the Start button.

During the test execution, the CTS 3.0 Software will continuously evaluate EUT Flicker against the appropriate IEC limits. The Pass or Fail indication is updated in real-time. If the test fails early in a long test period, you may elect to abort the test prematurely rather than wait till the end.

6.5 Printing Results

The CTS 3.0 Software can produce a WORD based report. At the end of test, the report button will be enabled. Clicking on the Report button will generate information needed for a report and present an option to generate a report in WORD.

6.6 Flicker Replay Mode

The CTS 3.0 Software can be used to replay previously recorded test data. This replay can be done on the same test system that was used to record the original data or on an altogether different PC.

In order to replay a test, the data acquired during the test needs to be saved to a CTS native data file. If the save data option is not enabled in the additional setup window for Flicker, there is no way to replay a test later. The Pass or Fail result of any run on the actual test system PC is always logged however. If a different PC is used to play back data, the data files have to be transferred to this PC first. The test data files are stored in the following directory:

C:\Program Files\California Instruments\CTS\Data_files

6.6.1 To play back test on the actual test system PC, proceed as follows:

1. From the Test Menu, select 'Replay an existing test'. This will bring up a table showing all tests ever run on this system.
2. Select the test you want to replay by clicking on its row. If data for this test was stored and is available, the Replay Test button at the bottom will be enabled.
3. Click on the Replay Test button to start the replay process. This will bring up a standard Harmonics or Flicker test screen.
4. To start the replay process, click on the Start button. The data displayed will be taken from the stored data files. The replay mode is indicated in the lower right corner on the status bar.
5. The buffer rate and speed at which data is replayed can be controlled using the various settings in the Options menu. This may be required to adjust to the speed of the PC used.
6. The replay process can be halted at any time by clicking on the Stop button. This will stop the data at the buffer number shown in the lower left corner.

7. Once stopped, the data can be stepped forward or backward at various rates using the VCR style buttons in the lower left corner.
8. A test report can be printed from stored data in this mode. The actual date and time the data was recorded will be shown on the report in addition the report print date and time.

6.6.2 To play back test on a different PC from the test system PC, proceed as follows:

1. If not already done, install a copy of the CTS 3.0 software on the other PC. When launched, the absence of a data acquisition system will be detected and flagged. This is normal.
2. Transfer the data files to the PC used for replay, either using a network connection or disk.
3. From the File menu, select the Open Data File entry, This brings up the standard file open dialog box.
4. Locate and select the file to be replayed. Harmonics files start with the letter H, flicker files start with the letter F.
5. Click on the Open button to open the test data file. This will bring up the standard setup screen showing the settings that were used to acquire this data.
6. Click on OK to proceed to the main test window.
7. To start the replay process, click on the Start button. The data displayed will be taken from the stored data files.
8. The buffer rate and speed at which data is replayed can be controlled using the various settings in the Options menu. This may be required to adjust to the speed of the PC used.
9. The replay process can be halted at any time by clicking on the Stop button. This will stop the data at the buffer number shown in the lower left corner.
10. Once stopped, the data can be stepped forward or backward at various rates using the VCR style buttons in the lower left corner.
11. A test report can be printed from stored data in this mode. The actual date and time the data was recorded will be shown on the report in addition the report print date and time.

6.6.3 Flicker Replay Options

Data replay capability is an important diagnostic feature of the CTS 3.0 system. The end user has a great deal of control over the replay process. These user settings are located in the Options menu. The following options are available to control the replay process:

Menu Item	Description	
Recall Type	This option offers four choices for playback of data. Data is stored in acquisition windows or buffers. For Harmonics, acquisition windows are either 10, 12 or 16 cycles. For Flicker, acquisition windows are 1 second. Available recall choices are:	
	Every Window:	Every acquisition window is shown
	Every failed/distorted Window	Only acquisition windows with one or more failures are shown.
	Every Failed Source Window	Only acquisition windows with high AC source distortion are shown.
	Every Failed Current Window	Only
Recall Size	Amount of acquisition buffers or windows to be loaded from disk to memory during playback. The more windows are loaded, the further the user can back up in the data stream during playback. Thus, when selecting 100 buffers, the replay can be stopped and reversed up to 100 buffers. The recall size ranges from 0 to 1000 buffers.	
Replay Delay	Selects the time to wait between display data buffers during replay mode. On a fast PC, it may be useful to increase this time or the replay will run by too fast to see anything meaningful. Available delay times between buffers are 0.0 seconds for the fastest speed to 5.0 seconds for the slowest speed.	
Display Rate	This setting determines how many buffers are skipped for display purposes. While all data buffers are read from disk, only the selected buffer interval set here is displayed in the graphs. Available rates range from Every Acquisition to All the way to the End. The last setting means the data is read from disk all at once and the last buffer is displayed right away. The user can then back up using the VCR style keys in the lower left corner of the screen.	

Table 6-1 : IEC Flicker Replay Settings

7. IEC 61000-4-11 Voltage Dips and Variations Immunity Testing

7.1 About This Chapter

This chapters covers testing a device for compliance with the IEC 61000-4-11 Voltage Dips and Variations test standard. This test is supported through the CIGui32 or CIGuiSII AC source control program. If you purchased a 100-CTS or 300-CTS test system, which does not include a California Instruments AC source, you will not be able to perform these tests.

The CIGui32 or CIGuiSII supports two implementations of the IEC 61000-4-11 test standard, one based on the firmware option available for the i/iX Series and one implemented in the CIGui32 or CIGuiSII program itself that can be used with any supported AC source. If you are using an i/iX Series AC source, check your configuration window to see if this option is installed. The CIGui32 or CIGuiSII will automatically choose the correct implementation. This section covers the implementation that relies on the presence of the -411 firmware option. This is also the version that supports the -EOS (Electronic Output Switch) option required for AC source compliance. If the AC source you are using does not have this option or is a 1251RP, refer to the AC source manual instead.

7.2 Standard Revisions and EUT Classes

The–411 option supports both the first (1994-06) and the second edition (2004-03) of the IEC 61000-4-11 test standard as of firmware revision 2.38. Older firmware revisions only support the first edition. Contact support@calinst.com for upgrade information. If Edition 2.0 is supported, the standard revision can be selected when using the Cigui32 or CIGuiSII Windows program. From the front panel, there is no need to select the revision but data values can be set that support either version of the standard.

Generic tests files are distributed with the CIGui32 or CIGuiSII program for both editions of the test standard. Files applicable to Edition 2.0 have ED20 in their file name. Do not mix these files, as the data setup will not be correct if you do. To load a test file, select the Mode (Dips or Vars) and test standard revision first, then use the File, Open menu to load the test parameters. Test parameters can be a function of the EUT class. The different files provided with the program cover the various EUT classes. The relevant EUT class 1, 2, 3 or X is listed in the file names.

When using front panel operation, the user has to set levels for each individual test step in SINGLE mode.

7.3 Compliance Statement

Based on the hardware specifications of the AC source in use, not all requirements for IEC 61000-4-11 test generators may be met. In particular, the 1 to 5 microsecond rise and fall time called out in the specification is not met by most AC sources. This is unlikely to have any effect on the outcome of the test however. A unit that fails a voltage dropout with a 80 microsecond rise and fall time will not likely pass the same dropout performed at 5 microseconds rise and fall times and vice versa.

However, the -EOS option available for the iX Series AC sources may be added to meet the IEC 61000-4-11 source's rise and fall times.

Also, the 500 Amps inrush current capability is not met. This requirement does not have to be met if the unit under test does not draw more inrush current than the AC source can deliver. The peak current pre-test option may be used to verify inrush capability of the source for the unit under test.

7.4 Specifying Test Sequences for Dips and Variations

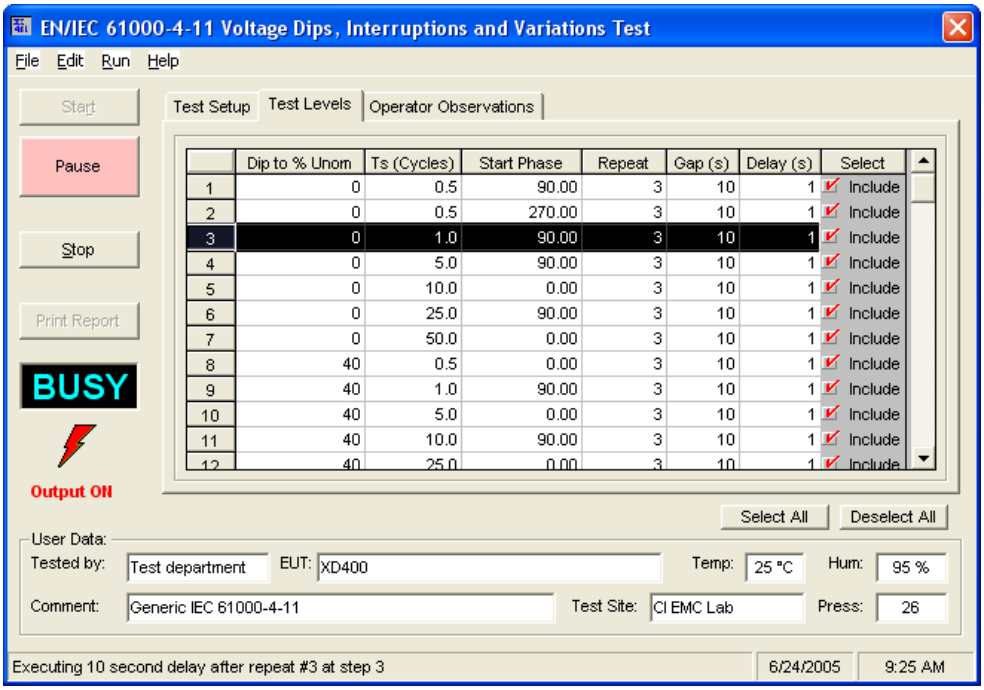

EN/IEC 61000-4-11 Voltage Dips, Interruptions and Variations Test
File Edit Run Help
Start
Pause
Stop
Print Report
BUSY
Output ON
Test Setup
Test Levels
Operator Observations
Dip to % Unom
Ts (Cycles)
Start Phase
Repeat
Gap (s)
Delay (s)
Select
1 0 0.5 90.00 3 10 1 Include
2 0 0.5 270.00 3 10 1 Include
3 0 1.0 90.00 3 10 1 Include
4 0 5.0 90.00 3 10 1 Include
5 0 10.0 0.00 3 10 1 Include
6 0 25.0 90.00 3 10 1 Include
7 0 50.0 0.00 3 10 1 Include
8 40 0.5 0.00 3 10 1 Include
9 40 1.0 90.00 3 10 1 Include
10 40 5.0 0.00 3 10 1 Include
11 40 10.0 90.00 3 10 1 Include
12 40 25.0 0.00 3 10 1 Include
Select All
Deselect All
User Data:
Tested by: Test department
EUT: XD400
Temp: 25 °C
Hum: 95 %
Comment: Generic IEC 61000-4-11
Test Site: CI EMC Lab
Press: 26
Executing 10 second delay after repeat #3 at step 3
6/24/2005
9:25 AM

Figure 7-1: IEC 61000-4-11 Test Window

The IEC 61000-4-11 test suite consists of two types of tests:

Dips and Interruptions	Simulates short interruptions in AC supply
Voltage Variations	Simulates slow changes in AC supply

The user must select the desired test type before executing the test. Since both test types require a number of test parameters, the test sequence parameters must be entered in the data entry grid or loaded from disk using the File, Open menu entry.

The timing of voltage variations is different between editions 1.0 and 2.0 of the IEC 61000-4-11 test standard. While the original standard used voltage ramps on both sides of the variation test level, the Edition 2.0 standard calls out an abrupt drop to the test level, followed by a voltage ramp back to the nominal voltage. Thus, for Edition 2.0, the fall time must be set to 0 cycles. This requires firmware revision 2.38 or higher. Older firmware revision will not accept 0 cycles for fall time. The shortest allowable fall time for older revision firmware is 0.02 sec.

Furthermore, where under Edition 1.0 rise and fall times were specified in seconds, they are specified in number of cycles in Edition 2.0. This is an effort to normalize both 50 Hz and 60 Hz voltage variations. The data entry mode used by the Cigui32 or CIGuiSII program will be a function of the edition selected by the user.

Refer to Figure 7-2 and Figure 7-3 for an illustration of how these parameters affect the V RMS output under the different standard revisions.

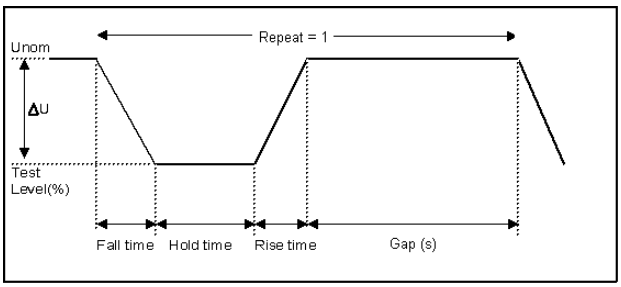


Figure 7-2: IEC 61000-4-11 Voltage Variation specification- Edition 1.0

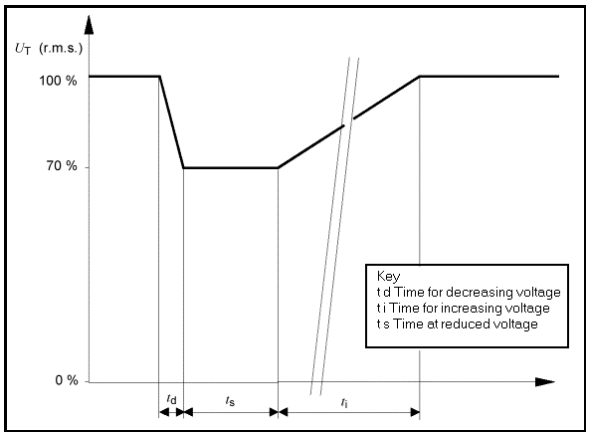


Figure 7-3: IEC 61000-4-11 Voltage Variation specification- Edition 2.0

Note that the generic IEC 61000-4-11 specifications are based on common types of AC line disturbances found on the European utility network. The test voltage levels and dip durations required to perform a IEC 61000-4-11 tests is not uniquely defined. Instead, different test levels and durations are allowed for various product categories. Product committees set these test levels. For this reason, the test parameters used by the CIGui32 or CIGuiSII for the IEC 61000-4-11 test sequences can be specified by the user or loaded from disk. This allows unlimited customization of both voltage interruptions and voltage variations tests. Up to 100 sequences of voltage dips at various levels, phase angles and durations can be specified. Voltage variations can be defined by level, rise time or t_d, fall time or t_i and hold time or t_s depending on the standard revision selected.

7.5 Test Setup

The following parameters and controls are available for executing the IEC 61000-4-11 test:

Parameter	Description
Nominal frequency	Opening this window will set this parameter to the present steady state frequency setting of the AC source. If required, a new value can be entered to be used during the test. At the end of the test, the AC source will remain at this frequency.
Test mode	Available test types are Dips and Variations..
Phase	The phase mode used is shown below the class selection. This mode cannot be changed from this window. To change phase mode, close this window and use the main front panel control window to select the desired phase mode first.
Peak Current Mode	User can select this option to verify that the test is valid. If the peak current is over the limit of the power source, a message will appear and the user can select abort or continue running the test
Run menu Start Button	Starts the IEC 61000-4-11 test using the parameters set by the user. Test progress is shown at the bottom of the window. The sequence numbers shown correspond to those in the illustration.
Stop	Aborts test in progress.

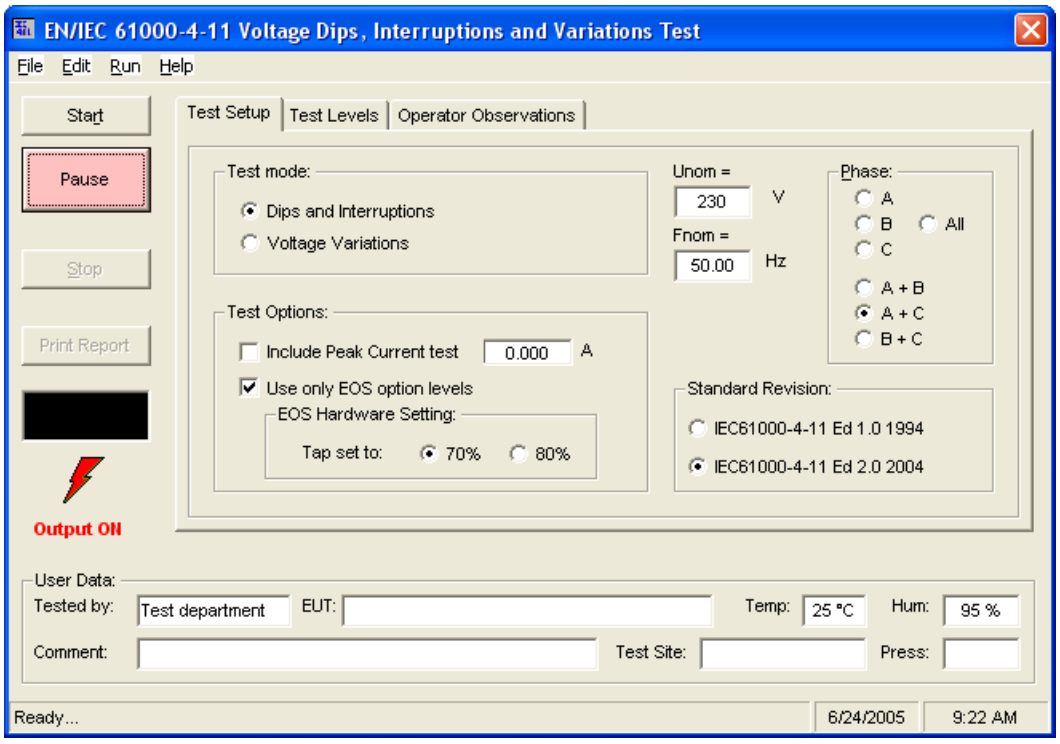


Figure 7-4: IEC 61000-4-11 Setup screen

7.6 Test Options

The operator may select one or more of the following options before starting the test:

Include Peak Current Test	The test standard requires that the AC generator used has the ability to deliver 500 Amps of inrush current to the EUT. This is neither economical nor practical. Instead, the EUT inrush current can be determined using a prescribed test method. If the EUT inrush current is 70 % or less of the AC sources' capability, the AC source may be used for full compliance testing. Setting this option determines the EUT inrush current using the standard method. The test takes about 12 minutes to complete. At the end, the program will inform the operator of the result and match this against the AC source's capability. See paragraph 7.3.
Use only EOS option levels	This option can only be selected if the Electronic Output Switch (EOS) option is present. When set, the test levels entered in the Dips test sequence or loaded from disk are automatically rounded to the nearest available discrete EOS voltage Dip level. If this option is not selected, any test level may be set but the EOS will be bypassed. In this case, the voltage rise and fall time required for full compliance will not be met. See compliance statement below. If the EOS-1 or EOS-3 has a dual tap setting for the 70/80 % tap, indicate the setting of this tap in the EOS Hardware Setting box as there is no way for the program to determine the setting in effect. For information on changing between 70 and 80% taps on the EOS1/EOS3, refer to the iX Series User Manual, P/N 7000-970, Revision Q or higher. See paragraph 7.3.

7.7 Test Results

There is no way for the CIGUI to determine the outcome of this test as a clear definition of a failure can not be given. The draft standard called out the following possible test results:

> *"The test results shall be classified on the basis of the operating conditions and functional specifications of the equipment under test, as in the following, unless different specifications are given by product committees or product specifications.*
>
> *a) Normal performance within the specification limits*
>
> *b) Temporary degradation or loss of function or performance which is self-recoverable.*
>
> *c) Temporary degradation or loss of function or performance which requires operator intervention or system reset.*
>
> *d) Degradation or loss of function which is not recoverable due to damage of equipment (components) or software, or loss of data.*
>
> *As a general rule, the test result is positive if the equipment shows its immunity, for the duration of the application of the test, and at the end of the tests the EUT fulfills the functional requirements established in the technical specification."*

The user has to make this determination by observing the unit under test.

7.8 Report Format- 411 Test Files

The IEC 61000-4-11 test module produces a test report when the Print Report button is clicked. Reports can also be printed from the File, Print menu. Test reports include all selected test parameters and options. A sample test report is shown below. The report format used can be direct output to a printer, output to a text file or generation of an MS Word report. The desired report format can be selected from the Options menu, under IEC Report Setup. MS Word reports are automatically saved in the C:\Program Files\California Instruments\Cigui32\Reports or C:\Program Files\California Instruments\CiguiSII\Reports directory.

8. IEC 61000-4-13 Harmonics and Interharmonics Immunity Test

8.1 About this Chapter

The IEC413 option is capable of performing IEC 61000-4 section 13 Harmonics and inter harmonics low frequency immunity tests. The tests are based on IEC 61000-4-13:2002-03, First Edition. It is assumed that the user has a copy of the test standard available. This manual section only cover operation of the –413 option from the front-panel of the iX Series power source.

Note 1: The initial release of the –413 option for the iX Series power sources was based on a draft version (CDV) of the IEC 61000-4-13 standard. Minor changes were made between the CDV draft and the final released version. Units with firmware revision 2.37 or higher conform to the official released IEC standard. Units with older firmware conform to the draft version. A firmware upgrade can be ordered through California Instruments' service department by contacting support@calinst.com and requesting part number CIC463. Provide the model and serial number of the unit (master unit in multi-box systems) to ensure the correct firmware is provided. The firmware revision is displayed on the LCD screen immediately after power up for a few seconds. It can also be queried over the bus using the "*IDN?" command.

Where relevant, the requirement for the correct firmware revision to obtain specific test modes is indicated in this manual.

Note 2: The –413 option is only available on iX Series AC power sources, not i Series. It is possible to upgrade most i Series AC source to an iX Series and add the –413 option. Contact the California Instruments service department for information. support@calinst.com.

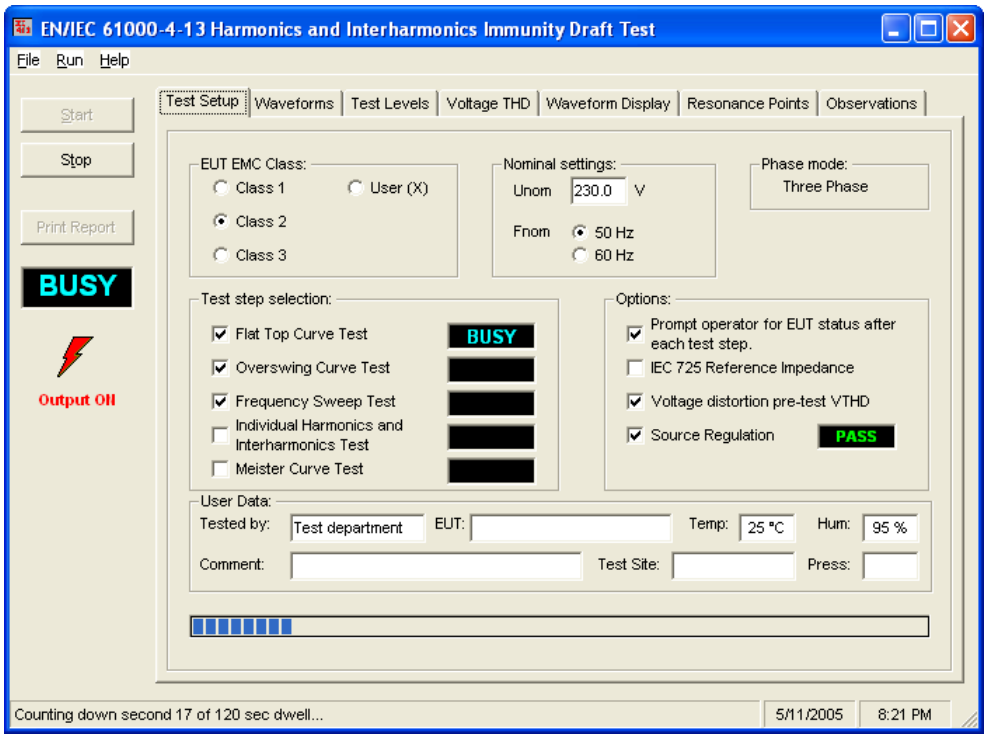


Figure 8-1: IEC 61000-4-13 Test Window

8.2 Tab Controls

The IEC 1000-4-13 Harmonics and Interharmonics test offers range of sub-tests and user options. We recommend you familiarize yourself with the actual standard document. IEC standards are available through www.iec.ch.

The following help screens contain information on setting test options using the available 413 tab controls located along the top of the IEC 1000-4-13 test window.

Tab	Description
Test Setup	User selected test options, EUT classes and test steps
Waveforms	Flat top curve and Over swing curve definitions
Test Levels	Sweep frequency ranges and test levels
Voltage Distortion	AC Source voltage distortion monitor display
Waveform Display	AC Source measured output waveform display
Resonance Points	EUT current as a function of frequency and resonance point summary.

The buttons on the left-hand side of the window may be used to start and stop a test run and print a test report.

Test parameters for Class X EUT's may be stored on and loaded from disk. This can be done using the File, Save and File, Open menus.

The results of a frequency sweep may be saved to disk for later recall as well. Data files have a .dat extension to distinguish them from a test setup file. (.413 extension) The Load and Save Data entries in the File menu are used for this purpose.

8.3 Test Setup

The Test Setup Tab contains several controls that allow the user to configure the IEC 61000-4-13 test to be run on the EUT. The various settings are as follows:

Parameter	Description
Phase mode	The available phase mode is shown in the top right corner and cannot be changed. For single-phase systems, phase A is always used as it is the only phase. For three phase systems, all stimuli are applied to all three phases.
EUT EMC Class	The test standard distinguishes between four classes of EUT, class 1 through 3 and a user defined class X. The user must select class 1, 2, 3 or X. Class X levels can be set in the Test levels Tab but must be equal than or higher than class 3 levels.
Nominal Settings	These values are normally obtained from the AC source's steady state setting when the test window is opened. They can be changed before running a test if needed. Note however than frequencies other than 50 or 60 Hz are not covered by the test standard.
Test Step Selection	There are four main test categories that may be selected. Consult the test standard for details on each step. Any combination of these four choices can be made.
Test Options	Prompt for EUT status: When checked, the program will prompt the operator for a Pass or Fail determination after each test step selected in the Test Step Selection box has been run. If this option is turned off, all test will be run and this dialog will only appear when all test are completed. IEC 725 Reference Impedance: If needed, the IEC 725 Flicker reference impedance may be used during the IEC 61000-4-13 test. When this option is checked, the iX Series will use its programmable impedance to implement the

Parameter	Description
	required reference impedance. Note that this capability may not be supported on all iX Series configurations. Voltage THD: When checked, the test program performs an AC Source voltage distortion pre-test and displays the result in the Voltage THD Tab. Source Regulation: When checked, the test program will checked the AC Source output voltage regulation with the EUT connected to ensure the AC source meets the test standard requirements.
User Data	The fields at the bottom of the Tab may be used to enter information on the person or entity performing the test, the EUT and any other comments that may be relevant. This information will be incorporated in the test report.

User selected EUT Class, test steps, options and nominal values are all included on the IEC 61000-4-13 test reports.

8.4 Test Sequence

The IEC 61000-4-13 standard specifies the following test flow diagram.

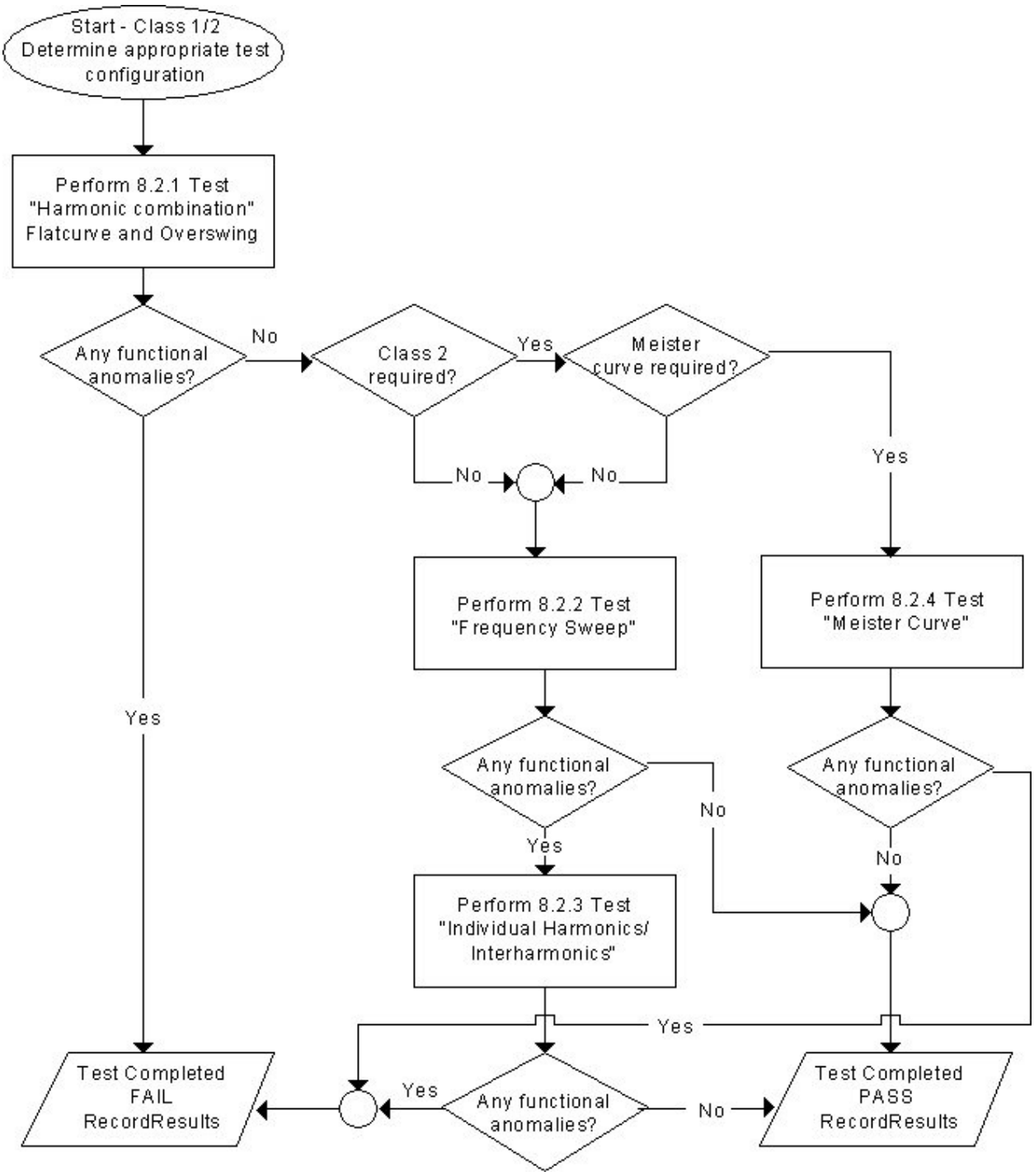


Figure 8-2: IEC 61000-4-13 Flow Chart Class 1 and 2.

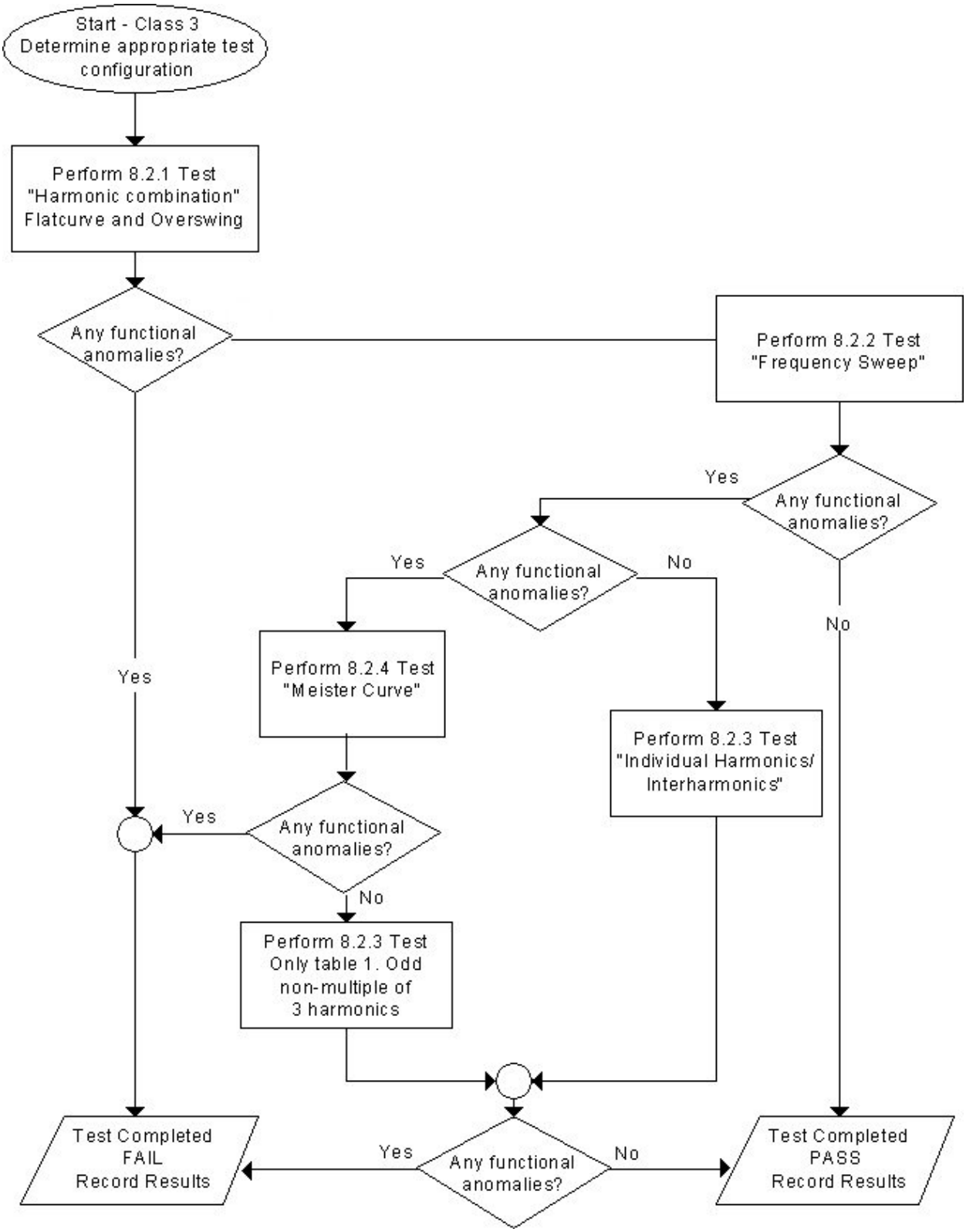


Figure 8-3: IEC 61000-4-13 Flow Chart Class 3.

The IEC 61000-4-13 test suite consists of five types of tests:

Test type	Description
Flat top Curve	Simulates specific waveform at the nominal voltage and frequency
OverSwing Curve	Simulates specific waveform at the nominal voltage and frequency
Frequency Sweep	Simulates frequency swept or stepped at a rate no less than 5 minutes per decade
Individual harmonics & Interharmonics	Simulates sinusoidal voltage superimposed on the fundamental voltage for 5 second at each frequency in a range from 2X to 40X fundamental.
Meister Curve	Special frequency sweep test to be used in countries where mains signaling and /or ripple control is applied.

The user must select the desired EMC Class and test type before executing the test. If choosing class X, the user can change any parameters but the levels have to be at least as high as those for Class 2.

The total test time using the default dwell times are as follows:

Test Step	Test Time
Flat Top Curve test:	Dwell time = 120 sec Pause time = 5 sec
OverSwing Curve test:	Dwell time = 120 sec Pause time = 5 sec
Frequency Sweep test:	Dwell time = 300 sec (per decade) *2.5 = 750 sec
Individual harmonics:	Dwell time = 5 sec (per harmonic) * 40 = 200 sec Pause time = 1 sec (per harmonic * 40 = 40 sec
Interharmonics:	Dwell time = 5 sec (per harmonic) * 147 = 735 sec Pause time = 1 sec (per harmonic) * 147 = 147 sec
Meister Curve:	Dwell time = 10 sec (per frequency step) * 147 = 1470 sec Pause time = 0 sec

Changes made to dwell times and test levels can be saved using the File, Save menu.

There are two .413 files distributed with the CIGui32 or CIGuiSII program. The Class2.413 and Class3.413 files are read-only files and can not be edited or changed. These files contain all parameters, which are determined by the product standard. When changing the Dwell and Pause times for Class 2 or Class 3, the user has to save the file under a different name.

8.4.1 Test Waveform Settings

The Waveforms Tab may be used to preview the Class 2 and Class 3 Flat top and Overswing waveforms. For class X, the waveform parameters may be entered in the controls to the left of the waveform display. Dwell times and pause times may be set for all classes.

Note that this Tab is only relevant if either the Flat Top or Overswing test steps are selected in the Test Setup tab.

8.4.2 Test Level Settings

The Test Levels Tab may be used to preview the Class 2 and Class 3 frequency ranges and test levels. For class X, this information may be edited. Dwell times and pause times may be set for

all classes. The following minimum and maximum values (in seconds) for dwell and pause times apply. Note that these values are queried from the AC source if present and may change if the firmware on the AC source is updated. As default, these times are set to their minimum values.

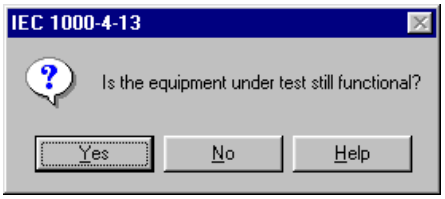
Test Type	Parameter	Minimum	Maximum
Sweep Frequency	Dwell	300	3600
Interharmonics	Dwell	5	600
	Pause	1	60
Harmonics	Dwell	5	600
	Pause	1	60
Meister Curve	Dwell	10	600
	Pause	0	60

Note that this Tab is only relevant if either the Flat Top or Over Swing test steps are selected in the Test Setup tab.

8.5 Test Results

There is no way for the CIGui32 or CIGuiSII to determine the outcome of this test, as a clear definition of a failure can not be given. The draft standard calls out the following possible test results:

> *"The test results shall be classified on the basis of the operating conditions and functional specifications of the equipment under test, as in the following, unless different specifications are given by product committees or product specifications.*
>
> *a) Normal performance within limits specified by the manufacturer, requestor or purchaser*
>
> *b) Temporary loss of function or degradation of performance which ceases after the disturbance ceases, and from which the equipment under test recovers its normal performance, without operator intervention.*
>
> *c) Temporary loss of function or degradation of performance, the correction of which requires operator intervention.*
>
> *d) Loss of function or degradation of performance which is not recoverable, owing to damage to hardware or software, or loss of data.*
>
> *As a general rule, the test result is positive if the equipment shows its immunity, for the duration of the application of the test, and at the end of the tests the EUT fulfills the functional requirements established in the technical specification."*



The user has to make this determination by observing the unit under test. At the end of the test, the GUI will pop up a dialog box asking the operator to assess the state of the EUT. This prompt can be selected to appear after each sub-test as by setting the "Prompt operator for EUT Status after each test step" option. The operator may answer Yes when prompted. If not, he should answer no. The response to this query is incorporated as a PASS or FAIL result in the test report.

8.6 Measurements

The following measurements are performed during the IEC 1000-4-13 test run.

8.6.1 Voltage Distortion Check

This is a data display Tab only. When selected in the test options, this Tab display the voltage distortion of the AC voltage supplied by the AC Source as measured at the EUT. The individual voltage harmonics must be below the IEC test standard levels set forth in IEC 61000-4-13. The test software checks against these limits and displays a PASS or FAIL result in both the Test Setup Tab and this Tab.

The result of the V THD check is included in the IEC 61000-4-13 Test report. Test results may be printed to the default Windows printer using the print button or the File, Print menu.

8.6.2 Voltage Waveform Time Domain

This Tab displays the voltage waveform as captured at the EUT by the iX Series' data acquisition system. This information is updated every couple of seconds and allows the user to monitor the stimulus applied to the EUT. This TAB is only used for display purposes and contains no user controls.

8.6.3 Resonance Points

During the test run, the voltage waveform is captured and displayed in the Waveform display Tab page. This allows the user to determine if the EUT continues to operate. There may be effects on the EUT such as reboots or processor lockups that cannot be seen by observing the EUT load current. Frequency is not measured as it remains at the nominal frequency specified.

The resonance points Tab displays the EUT current as a function of the harmonic and interharmonic frequencies applied to the EUT during the test. This information is displayed both numerically in the table on the left and graphically in the chart on the right. Those points that meet the criteria for a resonance point are listed in the table directly below the graph. Note that there may not be any resonance points on a given EUT. In that case, this table will be empty. The total number of resonance points found is shown between the graph and the resonance point table.

The are no user controls or settings on this Tab as it is used for data display only. Test results may be printed to the default Windows printer using the print button or the File, Print menu.

8.7 IEC 61000-4-13 Test Reports

The IEC 61000-4-13 test module produces a test report when the Print Report button is clicked. Reports can also be printed from the File, Print menu. Test reports include all selected test parameters and options. The report format used can be direct output to a printer or generation of an MS Word report. The desired report format can be selected from the Options menu, under IEC Report Setup. A sample section of an IEC 61000-4-13 test report is shown below. MS Word reports are automatically saved in the C:\Program Files\California Instruments\Cigui32\Reports or C:\Program Files\California Instruments\CiguiSII\Reports directory.

9. IEC 61000-4-14 Voltage Fluctuations Immunity Testing

9.1 About This Chapter

This chapters covers testing a device for compliance with the IEC 61000-4-14 Voltage Fluctuations test standard. This test is supported through the CIGUI AC source control program. If you purchased a 100-CTS or 300-CTS test system, which does not include a California Instruments AC source, you will not be able to perform these tests.

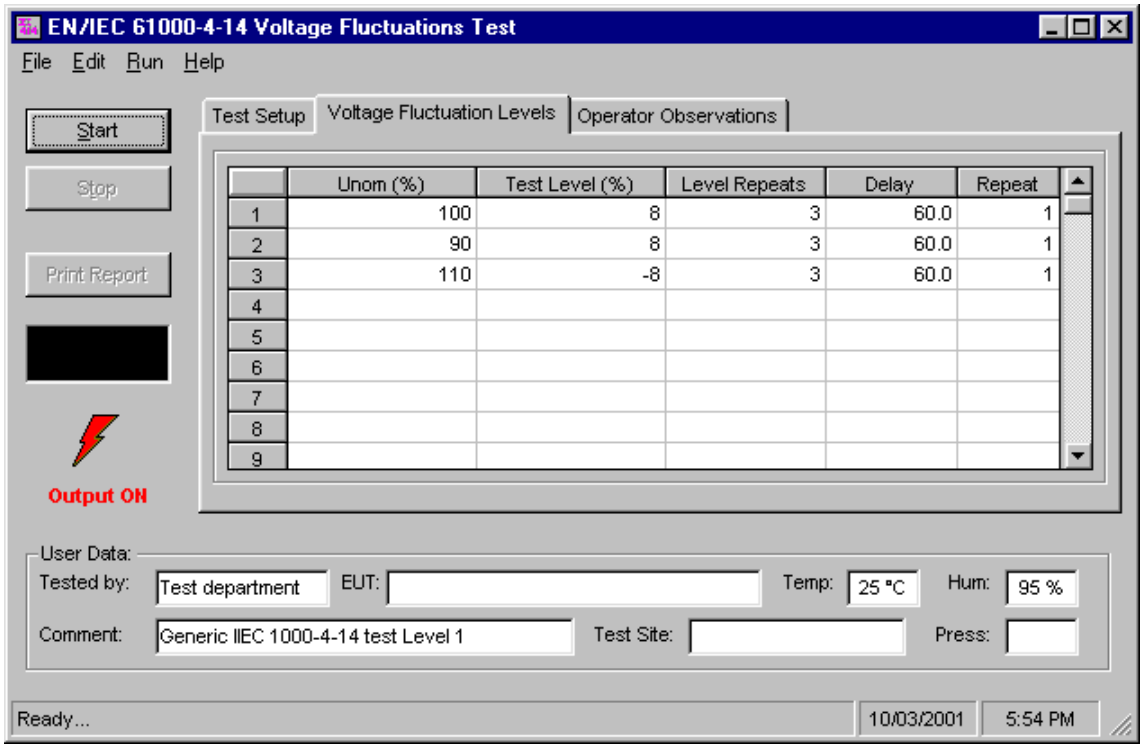


Figure 9-1: IEC 61000-4-14 Test Window

The IEC 61000-4-14 implementation in the CIGUI32 or CIGuiSII is based on the IEC 61000-4-14 standard dated 1999-02 and Amendment 1 dated 2001-07. Test levels and times can be changed if needed through the use of one or more *filename*.414_Fluc files in the IEC_Test directory.

9.2 Test Setup

The following parameters and controls are available for executing the IEC 61000-4-14 test:

Control / Field	Description
Nominal voltage	Opening this window will set this parameter to the present steady state voltage setting of the AC source. If required, a new value can be entered for use during the test. At the end of the test, the AC source will remain at this voltage level. If needed, the program will switch the AC source to the high voltage range and close the output relay when the test is started.
Nominal frequency	Opening this window will set this parameter to the present steady state frequency setting of the AC source. If required, a new value can be entered for use during the test. At the end of the test, the AC source will remain at this frequency.
Source Regulation	See under Test Options below
EUT Class	The EUT class determines the test levels used. Class selection is done by loading the correct class file from disk..
Phase Mode	The phase mode is determined by the AC source configuration. This mode cannot be changed from this window. To change phase mode, close this window and use the main front panel control window to select the desired phase mode first.
Start	Starts the IEC 61000-4-14 test using the parameters set by the user. Test progress is shown at the bottom of the window. The sequence numbers shown correspond to those in the illustration.
Stop	Aborts test in progress.

9.3 Test Options

The IEC 61000-4-14 test can be preceeded by a voltage regulation check. This check will check the output voltage regulation of the AC source driving the EUT at Vnom and at Vnom ± 10 %.

There are no other options selections that need to be made by the user.

9.4 Test Sequence

The test sequence implemented by this test consists of a series of voltage fluctuations consistent with commonly found phenomena on the public utility power grid. The objective of this test is to evaluate a product for immunity from such fluctuations.

Voltage fluctuations are applied at different levels for different product categories. The user must determine the product class and select the appropriate test level. During the test run, voltage changes are applied as specified by the selected test mode and for specified periods of time.

The test sequence can be programmed by setting the nominal voltage in %, the test level which is the change from the nominal voltage in %, the number of times each test level repeats (consecutive 5 second periods) and the delay between each set of test levels. Finally, each step in the sequence data grid can be repeated 1 or more times. (A Delay of 1 means the set it only run once.) The various columns in the test data setup are shown in the figure below. In this example, the following parameters were specified in the data entry grid:

Unom (%)	Test Level (%)	Level Repeat	Delay	Repeat
100	8	3	60	1

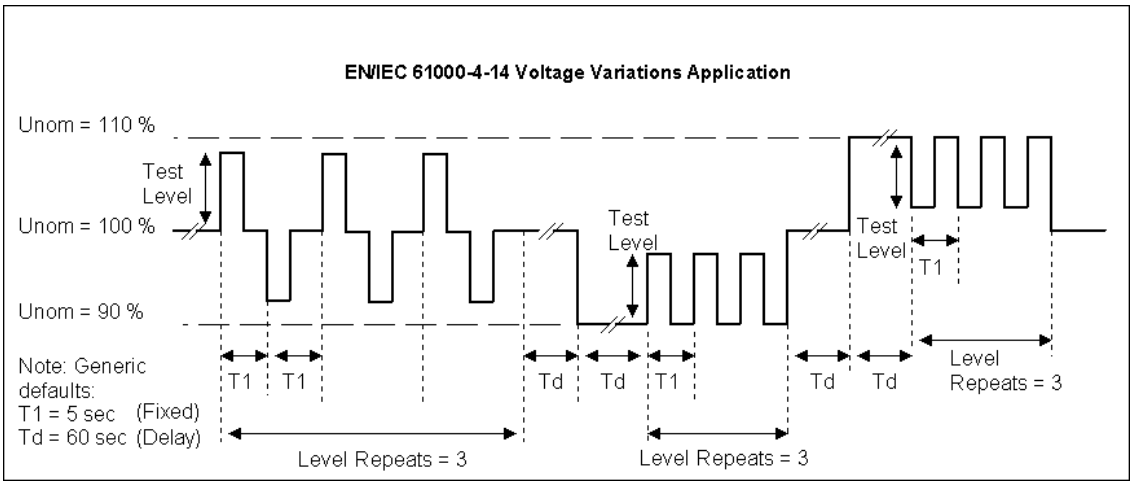


Figure 9-2: IEC 61000-4-14 Test Sequence

Note that the sequence of voltage changes is different if the Unom is at 100 % than at any other value. At 100 % Unom, the voltage changes occur in both positive and negative directions (alternating). If the test level (%) is set to a negative value and Unom is 100 %, the voltage changes are reversed.

These parameters can be entered on screen by the operator or loaded from disk. To load a new test or test class, select the File, Open menu. The default location for IEC test files is:

C:\Program Files\California Instruments\Cigui32\IEC_Test

Or

C:\Program Files\California Instruments\CiguiSII\IEC_Test

The following four IEC 61000-4-14 test files are distributed with the CIGui32 or CIGuiSII program:

File Name	Test Class
Generic IEC 1000-4-14 Test Class 2.414_Fluc	Class 2

File Name	Test Class
Generic IEC 1000-4-14 Test Class 3.414_Fluc	Class 3

The user may create as many test files as desired using the data entry grid. Changes made can be saved using the File, Save As… menu entry.

9.5 Test Levels

In Annex B of the draft standard, the EUT operating environment classifications are defined based on IEC 1000-2-4. The classifications are as follows:

Class	Environment
Class 1	Applies to protected supplies with compatibility levels lower than public network levels. It relates to the use of equipment, which is very sensitive to disturbances in the power supply, for instance the instrumentation of technological laboratories, some automation and protection equipment, some computers etc. This equipment is normally supplied by protected supplies such as uninterruptible power supplies, filers or surge suppressors.
Class 2	Applies to points of common coupling (PCCs for consumer systems) and in-plant points of common coupling (IPCs) in the industrial environment in general. The compatibility levels in this class are identical to those of public networks.
Class 3	Applies only to IPCs in industrial environments. It has higher compatibility levels than those of class 2 for some disturbance phenomena. This class should be considered when any of the following conditions are met: - a major part of the load is fed through converters - welding machines are present - large motors are frequently started - loads vary rapidly

Test levels are specified for class 2 and 3 only. Class X test levels may be defined by specific product standards.

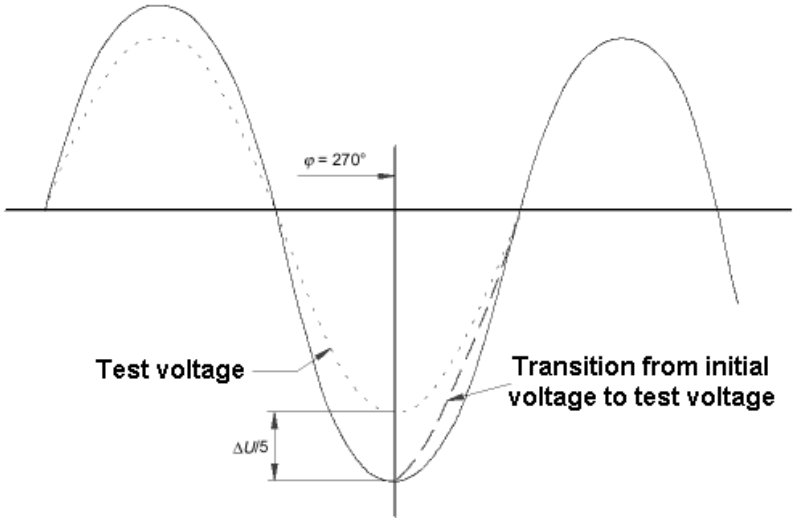
Environment Class	***Unom (Nominal Voltage)***	***Unom + 10 %***	***Unom - 10 %***
Class 1	no test required	no test required	no test required
Class 2	± 8 % Unom	- 8 % Unom	+ 8 % Unom
Class 3	± 12 % Unom	-12 % Unom	+ 12 % Unom
Class X	Open but must be higher than Level 2	Open but must be higher than Level 2	Open but must be higher than Level 2

9.6 Voltage Fluctuation

The IEC 61000-4-14 test standard specifies a specific voltage fluctuation methods for changing the voltage between test levels. This fluctuation is a combination of a series of 5 single period fluctuations, each having a 0.25 period slew starting at 270° phase angle of the voltage waveform. Thus, the complete rise (t_r) and fall (t_f) time of the voltage fluctuation includes the following two items:

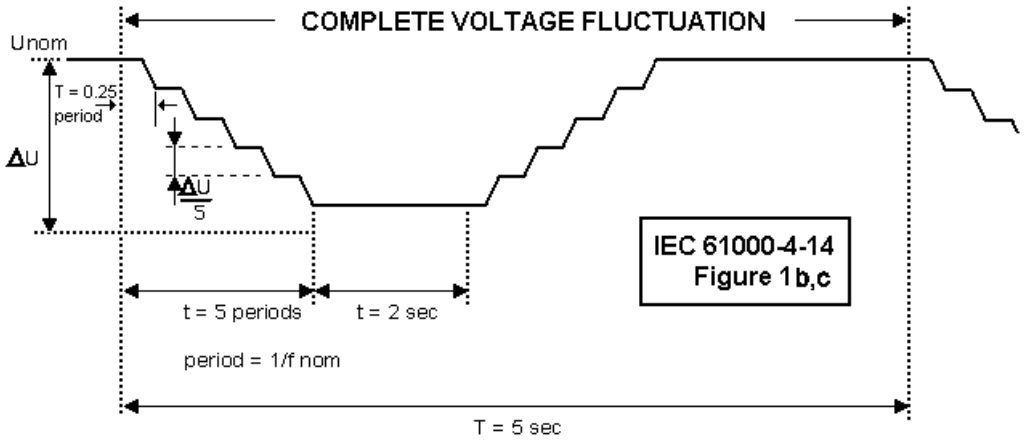
a) Single Period Fluctuation

Lasts for one period of the fundamental frequency. The voltage changes starts at the 270° phase angle and changes linearly for one quarter period until it reaches the next voltage level (delta Unom / 5) at 0°. This is illustrated in the figure below.



b) Complete Fluctuation

Five single period fluctuations as shown above combine into the complete voltage fluctuation to the test level. [Unom ± delta Unom] The test level is held for a 2 second period and then stepped back up or down to its nominal value. This is illustrated in the figure below which combines figures 1b and 1c of the IEC 61000-4-14 test standard.



Note: Prior versions of the Cigui32 (< 1.20.0.1) required a user selection between a slew or a stepped voltage fluctuation. Both have been combined per above description to more closely follow the IEC 61000-4-14 test standard.

9.7 Test Execution

The selected test mode can be started by pulling down the Run menu and selecting All or by clicking on the Start button. During test execution, no changes to test parameters are allowed. The test progress can be monitored at the bottom of the window in the status bar.

9.8 Test Parameter File Creation and Limits

New tests can be created by editing the data entry grid. The following test parameters are available for each test step. Note that the number of test steps is limited to 100 steps which should be more than adequate to cover any possible product standard.

Field	***Description***	***Range***
Unom (%)	Specifies the percentage of Unom to use for this test step. Typical values are 100 %, 110 % and 90 % for a 0, +10 and -10 change.	50 to 150 %
Test Level (%)	Specifies the percentage change from Unom to apply for this test step. Test levels are defined for different product classes.	-20 to +20 %
Level Repeats	Number of times specified test level is applied at this step. Normally, this value is set to 3. Each test level is applied for 2 seconds and repeats in 5 second window. The rise and fall times are set to 5 cycles each.	1 to 100
Delay (s)	Time is seconds between successive repeats of this test step.	0.1 to 999.9 sec.
Repeats	Number of times this test step is repeated. Normally, this value is set to 3.	1 to 100

9.9 Test Results

There is no way for the CIGUI to determine the outcome of this test as a clear definition of a failure can not be given. The draft standard called out the following possible test results:

"The test results shall be classified on the basis of the operating conditions and functional specifications of the equipment under test, as in the following, unless different specifications are given by product committees or product specifications.

a) Normal performance within limits specified by the manufacturer, requestor or purchaser

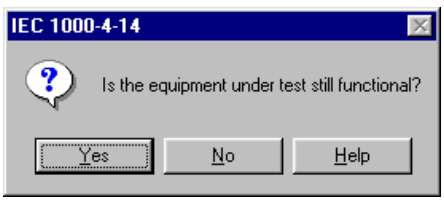
b) Temporary loss of function or degradation of performance which ceases after the disturbance ceases, and from which the equipment under test recovers its normal performance, without operator intervention.

c) Temporary loss of function or degradation of performance, the correction of which requires operator intervention.

d) Loss of function or degradation of performance which is not recoverable, owing to damage to hardware or software, or loss of data.

As a general rule, the test result is positive if the equipment shows its immunity, for the duration of the application of the test, and at the end of the tests the EUT fulfills the functional requirements established in the technical specification."

The user has to make this determination by observing the unit under test. At the end of a test run, the following dialog box is displayed. Click on the Help button to display the pass/fail criteria shown above.



9.10 Report Format- 414 Test Files

The IEC 61000-4-14 test module produces a test report when the Print Report button is clicked. Reports can also be printed from the File, Print menu. Test reports include all selected test parameters and options. A sample test report is shown below. The report format used can be direct output to a printer, output to a text file or generation of an MS Word report. The desired report format can be selected from the Options menu, under IEC Report Setup. MS Word reports are automatically saved in the C:\Program Files\California Instruments\Cigui32\Reports or C:\Program Files\California Instruments\CiguiSII\Reports directory.

10. IEC 61000-4-17 DC Ripple Immunity Testing

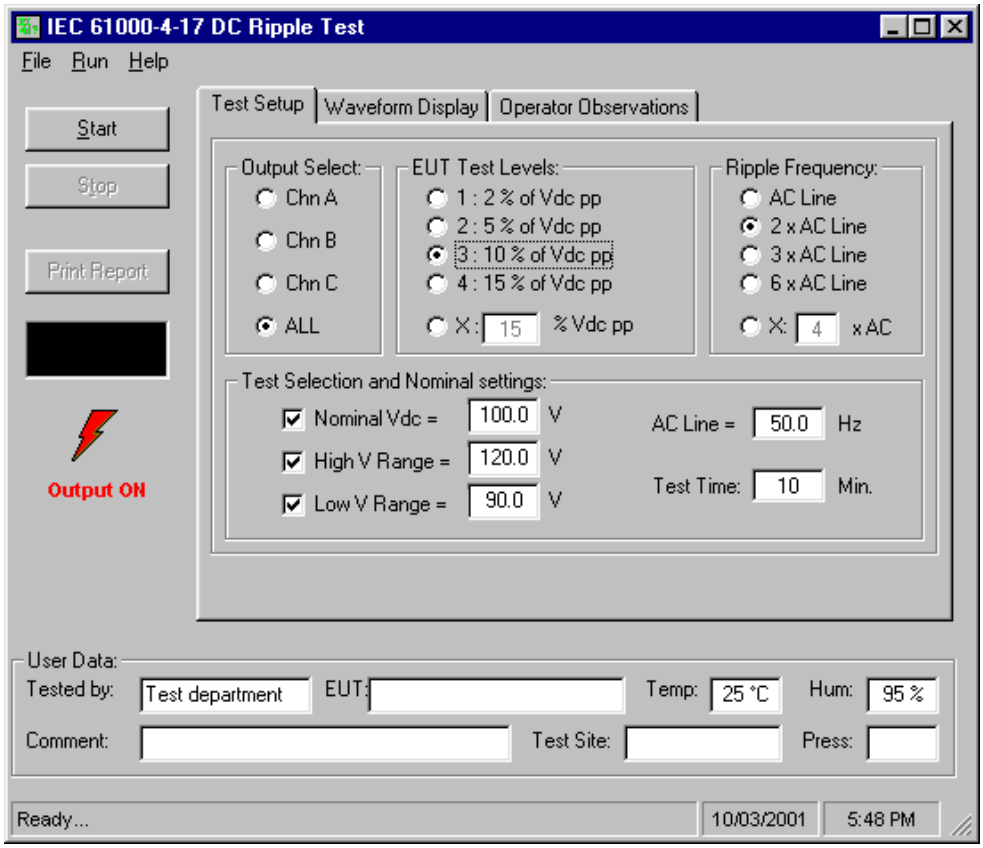


Figure 10-1: IEC 61000-4-17 Test Window

10.1 About This Chapter

This chapters covers testing a device for compliance with the IEC 61000-4-17 DC Voltage Ripple test standard. This test is supported through the CIGui32 or CIGuiSII AC source control program. If you purchased a 100-CTS or 300-CTS test system which does not include a California Instruments AC source or the CTS system uses an RP Series AC source, you will not be able to perform these tests.

The IEC 61000-4-17 implementation in the CIGUI32 or CIGuiSII is based on the IEC 61000-4-17 standard dated 1999-06. Test levels and ripple frequency can be changed if needed or set to one of the pre-defined test levels.

10.2 Test Setup

The following parameters and controls are available for executing the IEC 61000-4-17 test:

Control / Field	Description
Nominal DC voltage	This is the rated nominal DC supply voltage to the EUT. Both a high and low DC voltage range can be specified as well. When selected, the test will run at the selected voltage levels. This can any combination of nominal, high and low.
Line frequency	This sets the nominal AC line frequency. The ripple frequency will be a multiple of the AC Line frequency.
Output Select	For three phase systems, the output select enables one of three outputs or all three. The default is channel (phase) A.
EUT Test Levels	The test levels used are determined by the EUT class. Available levels are 2, 5, 10 or 15 %. A user defined test level from 0 to 25 % may be set as well.
Ripple Frequency	This fields sets the multiplier for the ripple frequency. Available settings are 1, 2, 3 and 6. A user defined multiplier is available as well.
Test Time	The default test time is 10 minutes. If more than one DC Voltage level is selected, the test time increases with this amount for each selected level. The test time can be set as low as 1 minute or as high as 9999 min.
Start	Starts the IEC 61000-4-14 test using the parameters set by the user. Test progress is shown at the bottom of the window. The sequence numbers shown correspond to those in the illustration.
Stop	Aborts test in progress.

10.3 Test Sequence

The test sequence implemented by this test consists of the application of an AC ripple of specified peak to peak value in percent of the DC voltage at a frequency determined by the multiplier times the AC Line frequency for a set period of time.

The ripple waveform consists of a sinusoidal linear waveshape as shown below. The objective of this test is to evaluate a product for immunity from such ripple.

10.4 Waveform Display

The DC output waveform is acquired at regular intervals during the test and can be displayed by selecting the Waveform Display tab.

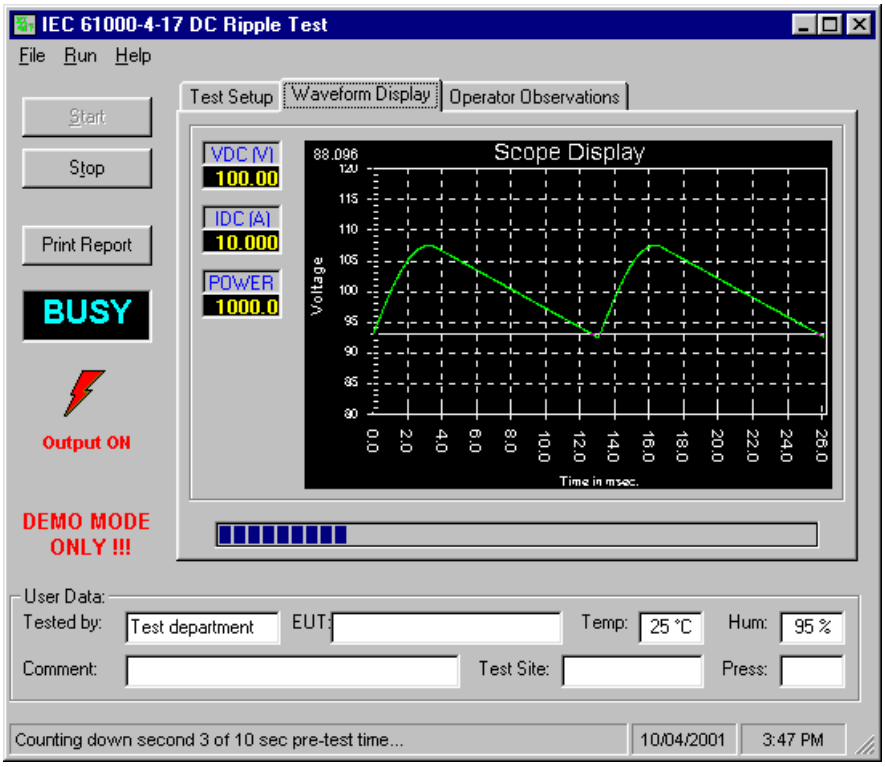


Figure 10-2: IEC 61000-4-17 Waveform Acquisition Window

10.5 Test Results

There is no way for the CIGUI to determine the outcome of this test as a clear definition of a failure can not be given. The draft standard called out the following possible test results:

> *"The test results shall be classified on the basis of the operating conditions and functional specifications of the equipment under test, as in the following, unless different specifications are given by product committees or product specifications.*
>
> *a) Normal performance within the specification limits*
>
> *b) Temporary degradation or loss of function or performance which is self-recoverable.*
>
> *c) Temporary degradation or loss of function or performance which requires operator intervention or system reset.*
>
> *d) Degradation or loss of function which is not recoverable due to damage of equipment (components) or software, or loss of data.*
>
> *As a general rule, the test result is positive if the equipment shows its immunity, for the duration of the application of the test, and at the end of the tests the EUT fulfills the functional requirements established in the technical specification."*

The user has to make this determination by observing the unit under test. At the end of a test run, the following dialog box is displayed. Click on the Help button to display the pass/fail criteria shown above.

10.6 User Observations

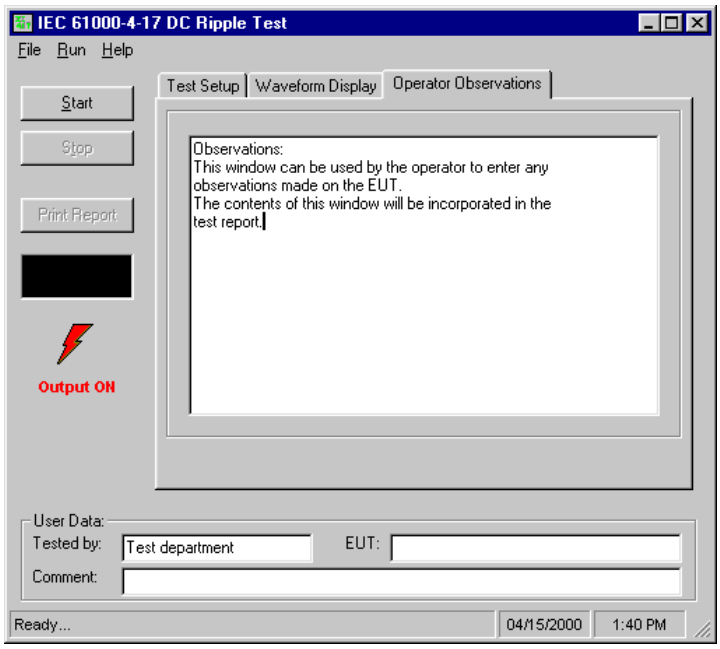


Figure 10-3: IEC 61000-4-17 User Observation Data Entry Window

The CIGUI32 or CIGuiSII provides a data entry window for the operator. Observations made about the EUT can be entered in this window before, during and after a test run. Any information entered by the operator in this window will be incorporated in the test report when printed.

10.7 Report Format- 417 Test Files

The IEC 61000-4-17 test module produces a test report when the Print Report button is clicked. Reports can also be printed from the File, Print menu. Test reports include all selected test parameters and options. A sample test report is shown below. The report format used can be direct output to a printer or generation of an MS Word report. The desired report format can be selected from the Options menu, under IEC Report Setup. MS Word reports are automatically saved in the C:\Program Files\California Instruments\Cigui32\Reports or C:\Program Files\California Instruments\CiguiSII\Reports directory.

10.8 Saving and Loading Test Setups

Frequently used test setups can be save to disk by using the File, Save or File Save As menu entries. Setup files for IEC 61000-4-17 tests have a ".417" file extension.

To select a previously saved test setup, use the File, Open menu entry and select the desired file from the file open dialog.

11. IEC 61000-4-27p Voltage Unbalance Immunity Testing

11.1 About This Chapter

This chapters covers testing a device for compliance with the IEC 61000-4-27 Voltage Unbalance in three phase AC power systems. test standard. This test is supported through the CIGUI32 or CIGuiSII AC source control program. If you purchased a 100-CTS or 300-CTS test system, which does not include a California Instruments AC source, you will not be able to perform these tests.

This test is only available on three-phase CTS Systems as it involves voltage and phase

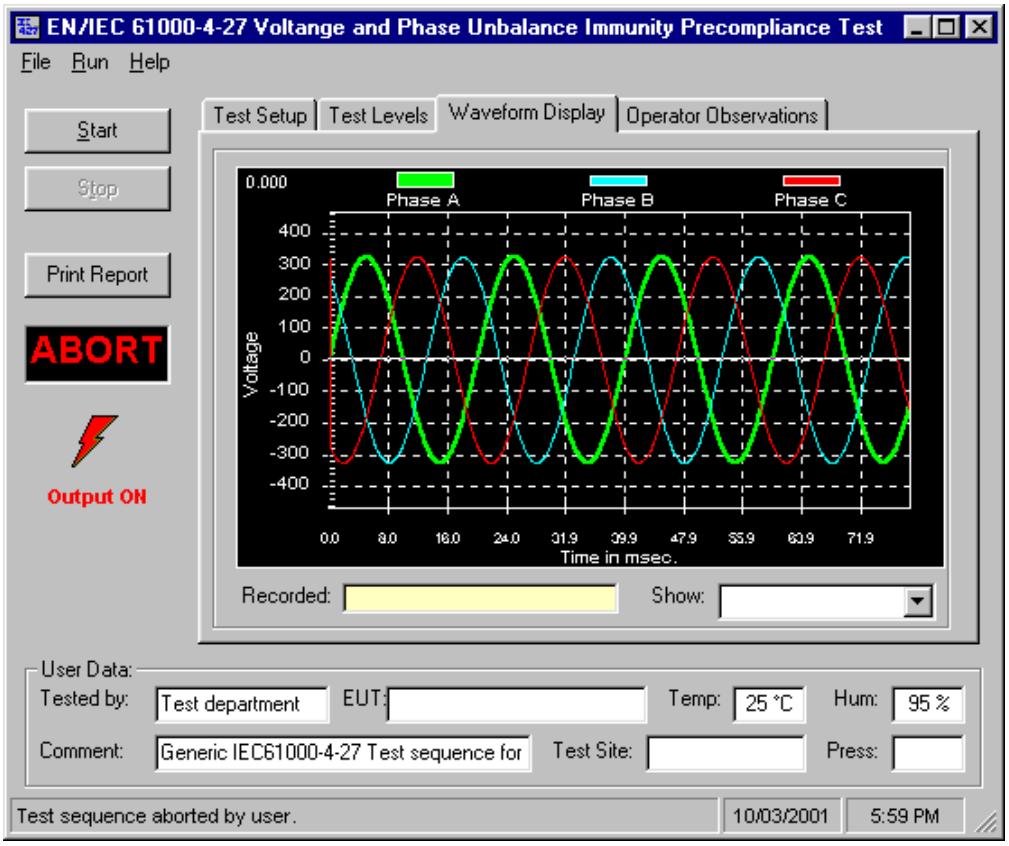


Figure 11-1: IEC 61000-4-27 Test Window

unbalance between three phases of a three phase supply network. The IEC 61000-4-27 implementation in the CIGUI32 or CIGuiSII is based on the IEC 61000-4-27 standard dated 2000-08. Test levels and durations can be changed if needed through use of one or more *filename*.427 files in the IEC_Test directory.

11.2 Test Setup

The required IEC 61000-4-27 test parameters must be entered in the test data entry grid before running a test. Previously stored test files can be loaded from the File, Open menu. Test files use a .427 file extension and only files with this extension can be loaded.

The CIGUI32 or CIGuiSII is distributed with a pre-defined test parameter files for the generic IEC 61000-4-27 product classes 2 and 3. Additional test parameter files e.g. for test level x, can be created by the user by editing the data entry grid and saving the new data under a user specified name.

The following parameters and controls are available for executing the IEC 61000-4-27 test:

Field / Control	**Description**
Nominal voltage	Opening this window will set this parameter to the present steady state voltage setting of the AC source. If required, a new value can be entered for use during the test. At the end of the test, the AC source will remain at this voltage level. If needed, the program will switch the AC source to the high voltage range and close the output relay when the test is started.
Nominal frequency	Opening this window will set this parameter to the present steady state frequency setting of the AC source. Available selections are 50 Hz or 60 Hz. At the end of the test, the AC source will remain at this frequency.
EUT Class	The EUT class determines the test levels used.
Test number	Allows selection of one or more test numbers. If all test numbers are selected, they will be executed in sequential order.
Performance Criterion	This selection will be used to indicate in the test report how the outcome of the test was evaluated. The criteria are explained here.
Execution Parameters	Number of sequences to run: A number of one indicates that the test level selected will be run one time per phase rotation for a total of 3 times. A number greater than one will result in repeating the same phase rotation that many times. Delay between sequences in minutes: A delay of 3 minutes minimum is required between tests. This value may be extended if desired. Pre-test delay in seconds: Time to wait in seconds between applying power to EUT and starting the first test sequence.
Phase Mode	This test is only valid when the power system is in three-phase mode so no phase mode selection is available. The phase mode is always three phase.
Start	Starts the IEC 61000-4-27 test using the parameters set by the user. Test progress is shown at the bottom of the window. The sequence numbers shown correspond to those in the illustration.
Stop	Aborts test in progress.

All IEC 61000-4 tests require setting of the rated nominal voltage and frequency of the EUT. The nominal values must be entered in the Test Setup Vnom and Fnom data fields before starting a test. When the IEC 61000-4 test windows is first opened, the present AC source settings are automatically loaded as the nominal values. These values are overridden by selecting each data entry field and typing in a new value or by loading a test parameter file from the File, Open menu. Thus, test data file also contain the nominal voltage and frequency values to be used.

11.3 Equipment Classifications

In Annex B of the standard, the EUT operating environment classifications are defined based on IEC 61000-2-4. The classifications are as follows:

Class 1	Applies to protected supplies with compatibility levels lower than public network levels. It relates to the use of equipment, which is very sensitive to disturbances in the power supply, for instance the instrumentation of technological laboratories, some automation and protection equipment, some computers etc. This equipment is normally supplied by protected supplies such as uninterruptible power supplies, filers or surge suppressors.
Class 2	Applies to points of common coupling (PCCs for consumer systems) and in-plant points of common coupling (IPCs) in the industrial environment in general. The compatibility levels in this class are identical to those of public networks.
Class 3	Applies only to IPCs in industrial environments. It has higher compatibility levels than those of class 2 for some disturbance phenomena. This class should be considered when any of the following conditions are met: - a major part of the load is fed through converters - welding machines are present - large motors are frequently started - loads vary rapidly

Testing is not recommended for Class 1 equipment. Test level X specifications are to be agreed upon by the manufacturer and user. Test Levels for environmental Class 2 and 3 equipment are defined by the generic standard. A user class X (user) with test level equal or higher than those of level 2 may be set as well.

11.4 Test Levels

The test sequence implemented by this test consists of a series of voltage and phase unbalance variations consistent with commonly found phenomena on the public utility power grid. The objective of this test is to evaluate a product for immunity from such variations.

Voltage unbalances are applied at different levels for different product categories. The user must determine the product class and select the appropriate test level. During the test run, voltage and phase changes are applied. The voltage levels and phase shifts are determined by the values set in the data entry grid. The various columns in the test data setup are as follows:

Parameter	**Description**	***Range***
Test #	Number of the test. There are three possible tests, 1, 2 and 3.	Fixed
Output	Indicates phase voltage for which level and phase is to be applied. For each test number, the test will be repeated three time using the following phase rotations: ABC, BCA, CAB	Fixed
% of Unom	Indicates voltage level to change to in % of nominal voltage.	50 to 150
Angle	Phase angle to shift to for each test number and phase in degrees.	0 to 360
Ku2	Unbalance factor. This value is shown for reference only and is based on the test levels and phase shifts. It is not directly used to program the AC source.	
Time (s)	Time in seconds to hold the unbalance condition	0.0 to 9999

These parameters can be entered on screen by the operator or loaded from disk. To load a new test or test class, select the File, Open menu. The default location for IEC test files is:

C:\Program Files\California Instruments\Cigui32\IEC_Test.

Or

C:\Program Files\California Instruments\CiguiSII\IEC_Test.

The following four IEC 61000-4-27 test files are distributed with the CIGui32 or CIGuiSII program:

File Name	**Test Class**
Class2.427	2
Class3.427	3
ClassX.427	X

The user may create as many test files as desired using the data entry grid. Changes made can be saved using the File, Save As… menu entry.

11.5 Waveform Display Tab

This tab displays the three phase output voltage waveforms and their respective phase angles. Each phase is shown in a different color. This waveform capture is started 10 msec prior to each voltage and phase change and covers a period of about 100 msec. The last unbalance data display is incorporated in the test report.

11.6 Operator Observations Tab

This tab may be used to enter any comments concerning the EUT behavior. Any text entered on this page will become part of the test report. Note that this information is not saved any where other then as part of the test report.

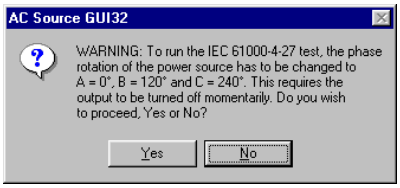
11.7 Source Regulation

The voltage regulation of the AC Source is always verified. The voltage regulation check verifies AC source voltage regulation at the beginning of each test under load as called out in the test standard. The voltage regulation must be less than 2 %. The measured output voltage must be within the source regulation limits specific in the IEC 61000-4-27 standard. If the source regulation check fails, check the system connections. For higher power loads, make sure the external sense lines are used to sense the voltage at the EUT terminals.

11.8 Test execution

The selected test mode can be started by pulling down the Run menu and selecting All or by clicking on the Start button. During test execution, no changes to test parameters are allowed. The test progress can be monitored at the bottom of the window in the status bar.

Note that the default phase rotation of the iX Series AC power systems is A = 0, B = 240 and C = 120 (counter clock wise). For the IEC 61000-4-27, the phase rotation must be set to A = 0, B = 120 and C =240. This is best done with the power to the EUT off. If the test is started and the iX phase rotation is not A = 0, B = 120 and C =240, a warning will appear prompting the operator to confirm the change in phase rotation. Selecting No will abort the test with no change to the source output. Selecting Yes will result in the phase rotation being changed before the test starts. If the phase rotation is already correct, no message appears.


AC Source GUI32
WARNING: To run the IEC 61000-4-27 test, the phase rotation of the power source has to be changed to A = 0°, B = 120° and C = 240°. This requires the output to be turned off momentarily. Do you wish to proceed, Yes or No?
Yes
No

11.9 Test Implementation and Test Sequence

For each test step, the specified voltage and phase angles will be applied for the time specified. At the onset of each voltage/phase step, the source voltage is captured by the power source's data acquisition system. Once the specified time has elapsed, the voltage and phase angles are set back to their nominal values and the captured waveform data is transferred and displayed. This data will be visible until the next step when it is updated. Each step (number) will be applied for a different phase rotation in the sequences shown below. This means the operator does not have to reconnect the EUT three times using a different phase connected at each test number.

The phase rotations used are as follows:

Sequence			
First	Ua to L1	Ub to L2	Uc to L3
Second	Ua to L2	Ub to L3	Uc to L1
Third	Ua to L3	Ub to L1	Uc to L2

The test numbers executed are determined by the test selection in the main setup screen. Any combination of test number 1, 2 and 3 may be selected by placing a check mark in the appropriate box.

11.10 Test Reports

The IEC 61000-4-27 test module produces a test report when the Print Report button is clicked or the File, Print menu is selected. Test reports include all selected test parameters and options. Note that IEC reports can be generated using one of three alternative methods. See the options menu for details. The IEC 61000-4-27 report generator supports direct printer output or output to a MS Word document. The waveform display that is included in the report is the one that was captured at the last unbalance applied to the EUT.

12. IEC 61000-4-28 Frequency Variations Immunity Testing

12.1 About This Chapter

This chapters covers testing a device for compliance with the IEC 61000-4-28 Frequency Variations test standard. This test is supported through the CIGui32 or CIGuiSII AC source control program. If you purchased a 100-CTS or 300-CTS test system which does not include a California Instruments AC source, you will not be able to perform these tests.

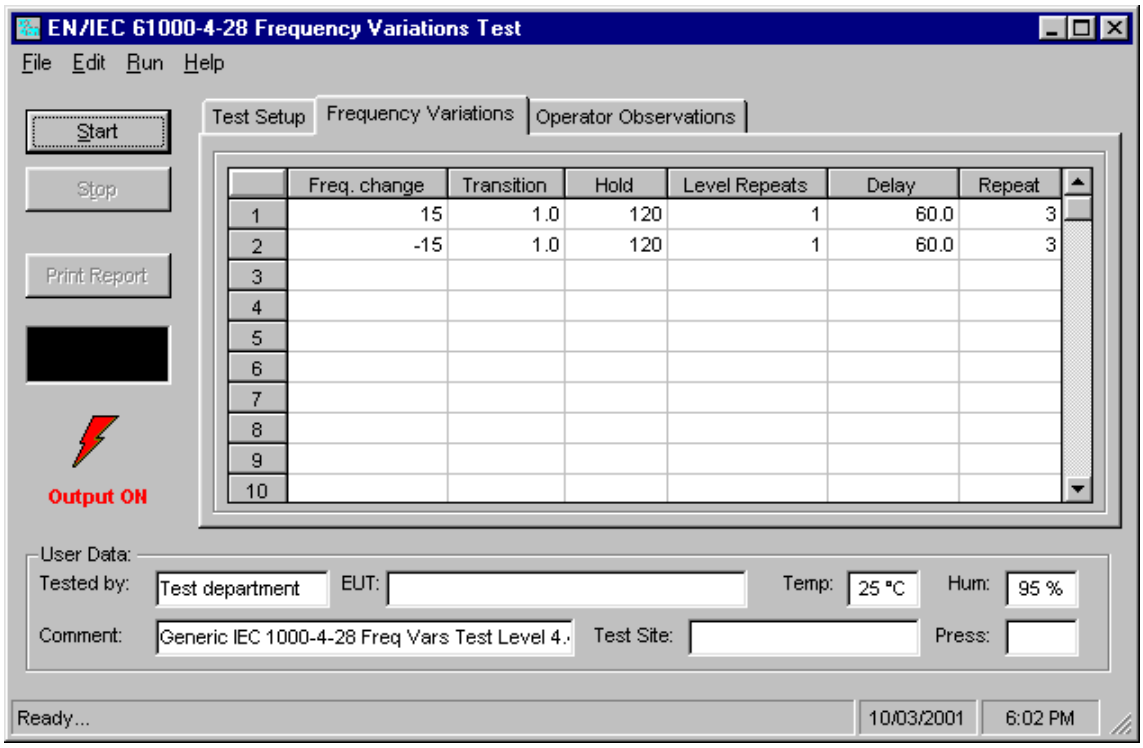


Figure 12-1: IEC 61000-4-28 Test Window

The IEC 61000-4-28 implementation in the CIGui32 or CIGuiSII is based on the IEC 61000-4-28 standard dated 1999-11 and Amendment 1, dated 2001-07. Test levels and durations can be changed if needed through use of one or more *filename*.428_Vars files in the IEC_Test directory.

12.2 Test Setup

The following parameters and controls are available for executing the IEC 61000-4-28 test:

Control / Field	Description
Nominal voltage	Opening this window will set this parameter to the present steady state voltage setting of the AC source. If required, a new value can be entered for use during the test. At the end of the test, the AC source will remain at this voltage level. If needed, the program will switch the AC source to the high voltage range and close the output relay when the test is started.
Nominal frequency	Opening this window will set this parameter to the present steady state frequency setting of the AC source. If required, a new value can be entered for use during the test. At the end of the test, the AC source will remain at this frequency.
Source Regulation	See under Test Options below
EUT Class	The test levels used are determined by the EUT class. Class selection is done by loading the correct class file from disk.
Phase Mode	Note that there is no Phase selection in this test as the programmed frequency always applies to all available phases.
Start	Starts the IEC 61000-4-28 test using the parameters set by the user. Test progress is shown at the bottom of the window. The sequence numbers shown correspond to those in the illustration.
Stop	Aborts test in progress.

12.3 Test Sequence

The test sequence implemented by this test consists of a series of frequency variations consistent with commonly found phenomena on the public utility power grid. The objective of this test is to evaluate a product for immunity from such variations.

Frequency variations are applied at different levels for different product categories. The user must determine the product class and select the appropriate test level. During the test run, frequency changes are applied at the zero degree phase angle of the waveform. Both up and down shifts of the frequency are performed. Test levels and test times are displayed in the test parameter data entry grid. The various columns in the test data setup are shown in the figure below. In this example, the following parameters were specified in the data entry grid:

Freq. Change	Transition	Hold	Level Repeat	Delay	Repeat
-15	1	120	2	60	3

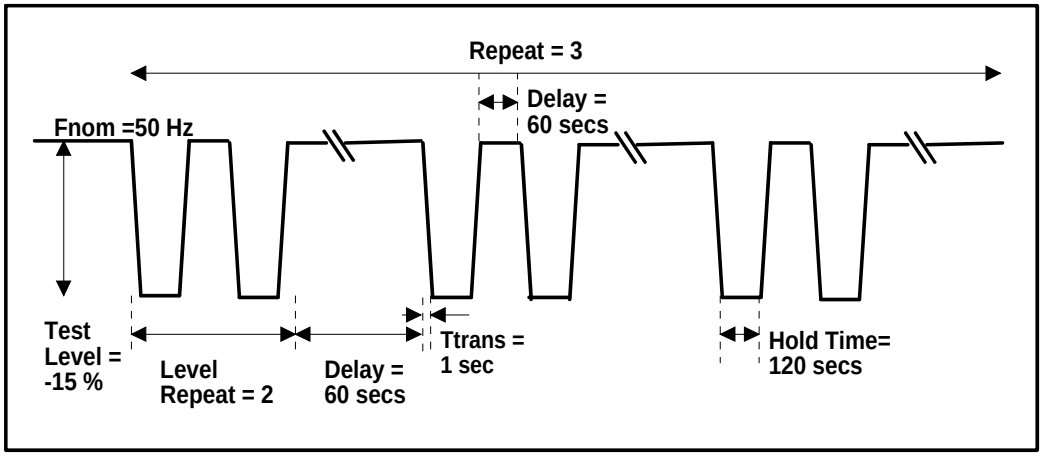


Figure 12-2: IEC 61000-4-28 Test Sequence

These parameters can be entered on screen by the operator or loaded from disk. To load a new test or test class, select the File, Open menu. The default location for IEC test files is:

C:\Program Files\California Instruments\Cigui32\IEC_Test

or

C:\Program Files\California Instruments\CiguiSII\IEC_Test.

The following four IEC 61000-4-28 test files are distributed with the CIGUI32 or CIGuiSII program:

File Name	Test Class
Generic IEC 1000-4-28 Freq Vars Test Level 2.428_Vars	Level 2
Generic IEC 1000-4-28 Freq Vars Test Level 3.428_Vars	Level 3
Generic IEC 1000-4-28 Freq Vars Test Level 4.428_Vars	Level 4

The user may create as many test files as desired using the data entry grid. Changes made can be saved using the File, Save As… menu entry.

12.4 Test Levels

In Annex B of the draft standard, the EUT operating environment classifications are defined based on IEC 1000-2-4. The classifications are as follows:

Class	Environment
Class 1	Applies to protected supplies with compatibility levels lower than public network levels. It relates to the use of equipment, which is very sensitive to disturbances in the power supply, for instance the instrumentation of technological laboratories, some automation and protection equipment, some computers etc. This equipment is normally supplied by protected supplies such as uninterruptible power supplies, filers or surge suppressors.
Class 2	Applies to points of common coupling (PCCs for consumer systems) and in-plant points of common coupling (IPCs) in the industrial environment in general. The compatibility levels in this class are identical to those of public networks.
Class 3	Applies only to IPCs in industrial environments. It has higher compatibility levels than those of class 2 for some disturbance phenomena. This class should be considered when any of the following conditions are met: - a major part of the load is fed through converters - welding machines are present - large motors are frequently started - loads vary rapidly

Testing is not recommended for Class 1 equipment. Test level X specifications are to be agreed upon by the manufacturer and user. Test Levels 2, 3 and 4 defined in the standard are applied to environmental Class 2 and 3 equipment. Test Level 3 is defined for interconnected networks and Level 4 for non-interconnected networks (islands for example) where the frequency variations can be much higher. The following table summarizes the EMC classes and test level relationships.

Test Level	***Environment classification***	***Frequency Variation***
Level 1	Class 1	No test required
Level 2	Class 2	± 3 % of Fnom
Level 3	Class 3 and 4 used in interconnected networks	+ 4 % and - 6 % of Fnom
Level 4	Class 3 and 4 used in non-interconnected networks	± 15 % of Fnom
Level X	Product class specific	Open but must be higher than test level 2.

12.5 Test Options

The voltage regulation of the AC Source can be verified by selecting the "Include Source Regulation Check" check box. This will cause the AC load to measure its output using the built in measurement system at all the frequency extremes that will be applied to the EUT during the test. The measured output voltage must be within the source regulation limits specific in the IEC 61000-4-28 standard. If so, a PASS indication will be shown in green to the right of the option box. If not, a FAIL indication will be shown in red. If the source regulation check fails, check the system connections. For higher power loads, make sure the external sense lines are used to sense the voltage at the EUT terminals.

Tests are started using the Start button or the Run, All menu.

12.6 Test Results

There is no way for the CIGUI to determine the outcome of this test as a clear definition of a failure can not be given. The draft standard called out the following possible test results:

"The test results shall be classified on the basis of the operating conditions and functional specifications of the equipment under test, as in the following, unless different specifications are given by product committees or product specifications.

a) Normal performance within limits specified by the manufacturer, requestor or purchaser

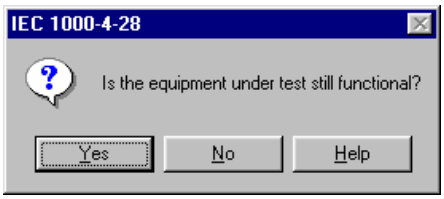
b) Temporary loss of function or degradation of performance which ceases after the disturbance ceases, and from which the equipment under test recovers its normal performance, without operator intervention

c) Temporary loss of function or degradation of performance, the correction of which requires operator intervention

d) Loss of function or degradation of performance which is not recoverable, owing to damage to hardware or software, or loss of data.

As a general rule, the test result is positive if the equipment shows its immunity, for the duration of the application of the test, and at the end of the tests the EUT fulfills the functional requirements established in the technical specification."

The user has to make this determination by observing the unit under test. At the end of a test run, the following dialog box is displayed. Click on the Help button to display the pass/fail criteria shown above.



12.7 Test Reports

The IEC 61000-4-28 test module produces a test report when the Print Report button is clicked. Reports can also be printed from the File, Print menu. Test reports include all selected test parameters and options. A sample test report is shown below. The report format used can be direct output to a printer, output to a text file or generation of an MS Word report. The desired report format can be selected from the Options menu, under IEC Report Setup. MS Word reports are automatically saved in the C:\Program Files\California Instruments\Cigui32\Reports or C:\Program Files\California Instruments\CiguiSII\Reports directory.

13. IEC 61000-4-29p DC Dips and Interruptions Immunity Test (Pre-compliance)

The IEC 61000-4-29 implementation in the CIGui32 or CIGuiSII is based on the IEC 61000-4-29

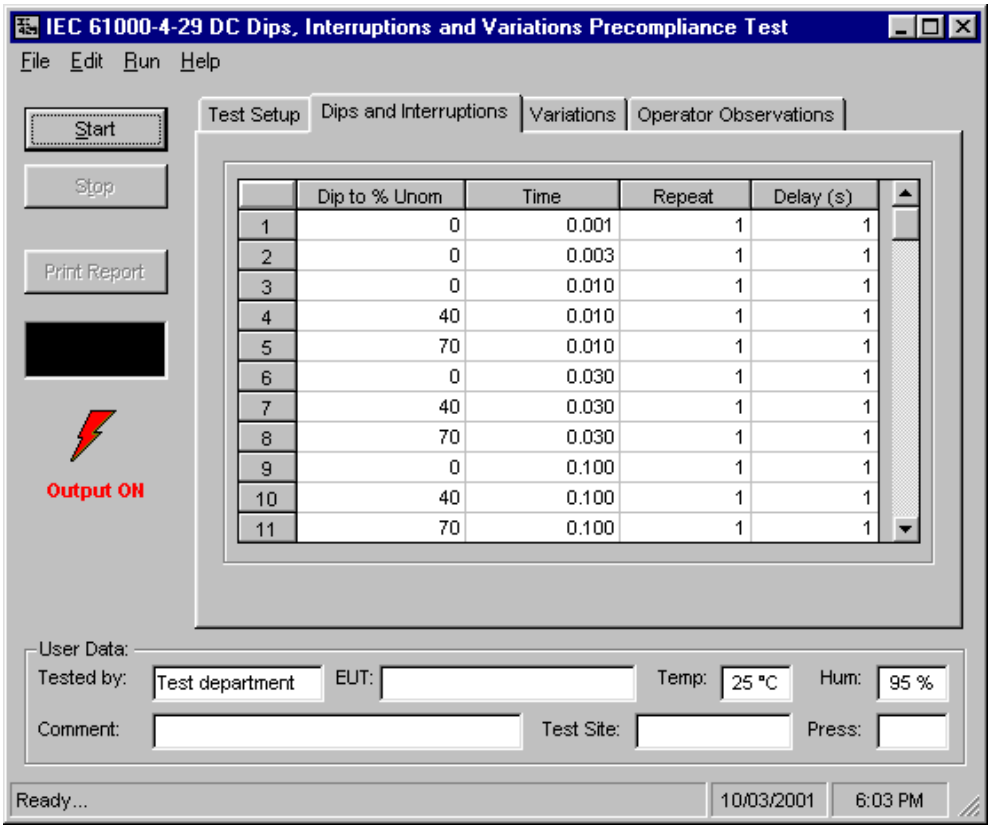


Figure 13-1: IEC 61000-4-29 Test Window

standard dated march 24, 2000. **This test is offered as a pre-compliance level test only.** Not all the DC supply rise and fall time and maximum current requirements can be met under all conditions. (See paragraph 13.8 for details.) Test parameters can be changed if needed using the parameter data entry grid. Several generic test parameter files are distributed with the CIGui32 or CIGuiSII program. These files can be edited as well. IEC 61000-4-29 Test setup parameter files use a ".429" extension. More than one .429 file may reside in the IEC_Test directory or any other directory. The operator may select the one to run from the File, Open dialog.

13.1 Test Setup

The following parameters and controls are available for executing the IEC 61000-4-29 test:

Parameter / Control	Description
Nominal DC voltage	Opening this window will set the upper voltage range parameter to the present steady state voltage setting of the DC supply. If required, a new value can be entered for use during the test. At the end of the test, the DC Supply will remain at this voltage level. The upper voltage range value entered cannot exceed the selected voltage range. Note that DC voltage variations to levels above 100 % of Unom may require selection of the high voltage range. The lower voltage range must be set to the lowest EUT rated Vdc. If the EUT voltage range is less than 20 % of its low range value, a single Vdc level may be used.
Sequence	Available sequences for selection are: Voltage Dips and Interruptions Voltage Variations. Either one or both sequences can be selected for execution.
Output Select	The output selection is shown to the left. If a 3 phase AC/DC power source model is used, this field allows selection of output channel A, B, C or all three channels (outputs). The same test sequence is applied to all selected outputs. For single phase power systems, this field defaults to channel A.
Start	Starts the IEC 61000-4-29 test using the parameters set by the user. Test progress is shown at the bottom of the window.
Abort	Aborts test in progress.

The required IEC 61000-4-29 test parameters must be entered in the test data entry grid before running a test. Previously stored test files can be loaded from the File, Open menu. Test files use a .429 file extension and only files with this extension can be loaded.

The CIGUI32 or CIGuiSII is distributed with pre-defined test parameter files for the generic IEC 61000-4-29 test sequences. Additional test parameter files e.g. for specific product categories, can be created by the user by editing the data entry grid and saving the new data under a user-specified name. The following parameters and controls are available for executing the IEC 61000-4-29 test:

Field / Control	**Description**
Nominal DC voltage	Opening this window will set the upper voltage range parameter to the present steady state voltage setting of the DC supply. If required, a new value can be entered for use during the test. At the end of the test, the DC Supply will remain at this voltage level. The upper voltage range value entered cannot exceed the selected voltage range. Note that DC voltage variations to levels above 100 % of Unom may require selection of the high voltage range. The lower voltage range must be set to the lowest EUT rated Vdc. If the EUT voltage range is less than 20 % of its low range value, a single Vdc level may be used. If the user selects only one of the two DC levels and the delta between them exceeds 20 % of the low DC range, a warning message will appear notifying the user of this condition. As a rule, both voltage must be selected for testing when this prompt appears.
Sequence Select	Available sequences for selection are:

Field / Control	Description
	Voltage Dips and Interruptions Voltage Variations. Either one or both sequences can be selected for execution.
Output Select	The output selection is shown to the left. If a 3 phase AC/DC power source model is used, this field allows selection of output channel A, B, C or all three channels (outputs). The same test sequence is applied to all selected outputs. For single phase power systems, this field defaults to channel A.
Start	Starts the IEC 61000-4-29 test using the parameters set by the user. Test progress is shown at the bottom of the window.
Abort	Aborts test in progress.

13.2 Setting nominal values

The IEC 61000-4-29 test requires setting of the rated nominal DC voltage of the EUT. The nominal values must be entered in the Test Setup Nom. Vdc data field before starting a test. When the IEC 61000-4 test windows is first opened, the present DC voltage setting is automatically loaded as the nominal Vdc value. This value is overridden by selecting each data entry field and typing in a new value or by loading a test file from the File, Open menu. Thus, test data files also contain the nominal Vdc voltage to be used.

13.3 Test sequence

The test sequence implemented by this test consists of a series of DC voltage dips (to less than DC nominal) or interruptions (dip to zero volt). It is also possible to select voltage variations which cause the DC voltage to change at a programmed rate to a specified level and then return at the same or a different rate to the nominal DC level. The objective of this test is to evaluate a product for immunity from such dips, interruptions and variations.

These dips and variations can be applied at different levels and durations for different product categories. The user must determine the product class and select the appropriate test file. The selected levels and durations are visible on screen and can be edited and saved to a new setup file if needed. This allows a library of test files for specific product categories to be created. The .429 file loaded determines the test levels and DC nominal values used. It can also contain information on the EUT and operator. The maximum number of steps that can be defined is 100 for both Dips/Interruptions and Variations.

These parameters can be entered on screen by the operator or loaded from disk. To load a new test or test class, select the File, Open menu. The default location for IEC test files is:

C:\Program Files\California Instruments\Cigui32\IEC_Test.

Or

C:\Program Files\California Instruments\CiguiSII\IEC_Test.

The following duplicate sets of IEC 61000-4-29 test files are distributed with the CIGui32 or CIGuiSII program:

For PC's using US Windows Settings (period as decimal separator), use the following files:
Generic IEC 1000-4-29 Voltage Variations.429
Generic IEC 1000-4-29 Voltage Dips.429
Generic IEC 1000-4-29 Voltage Dips Ints and Vars.429
Generic IEC 1000-4-29 Voltage Dips and Interruptions.429

For PC's using US Windows Settings (period as decimal separator), use the following files:
Generic IEC 1000-4-29 Short Interruptions.429

For PC's using European Windows Settings (comma as decimal separator), use the following files:
Euro Generic IEC 1000-4-29 Voltage Variations.429
Euro Generic IEC 1000-4-29 Voltage Dips.429
Euro Generic IEC 1000-4-29 Voltage Dips Ints and Vars.429
Euro Generic IEC 1000-4-29 Voltage Dips and Interruptions.429
Euro Generic IEC 1000-4-29 Short Interruptions.429

The user may create as many test files as desired using the data entry grid. Changes made can be saved using the File, Save As… menu entry.

13.4 Test Options

Nominal Voltage Mode

The IEC 61000-4-29 test standard allows testing at a single nominal Vdc value if the voltage range of the EUT is less than 20 % of the low range value. Thus, if an EUT has a nominal input range from 100 to 110 Vdc, the range is 10 V which is only 10 % of the low range value (10/100 = 10 %). In this case, either the upper or lower limit value or a value in between may be used to test the EUT. If the range exceeds 20 %, the test has to be performed at both upper and lower range settings. The CIGui32 or CIGuiSII will allow the operator to select single value testing but will prompt a warning if the values entered represent a greater than 20 % range.

Pre-Test Delay

For both Dips/Interruptions and Variations runs, it is possible to specify a pre-test delay. This is a period expressed in seconds during which the Vdc nominal value will be applied to the EUT before the actual test sequence starts.

13.5 Test Execution

The selected test mode can be started by pulling down the Run menu and selecting All or by clicking on the Start button. During test execution, no changes to test parameters are allowed. The test progress can be monitored at the bottom of the window in the status bar. The progress through each sequence can be monitored as well as each test step currently executing is highlighted.

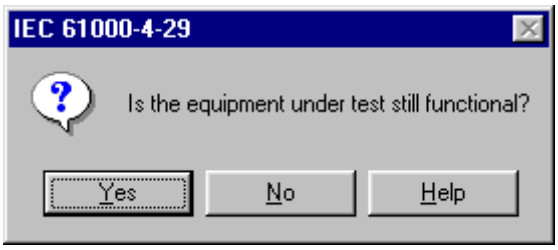
13.6 Test Results

There is no way for the CIGui32 or CIGuiSII to determine the outcome of this test as a clear definition of a failure can not be given. The draft standard called out the following possible test results:

> *"The test results shall be classified on the basis of the operating conditions and functional specifications of the equipment under test, as in the following, unless different specifications are given by product committees or product specifications.*
>
> *a) Normal performance within the specification limits*
>
> *b) Temporary degradation or loss of function or performance which is self-recoverable.*
>
> *c) Temporary degradation or loss of function or performance which requires operator intervention or system reset.*
>
> *d) Degradation or loss of function which is not recoverable due to damage of equipment (components) or software, or loss of data.*

As a general rule, the test result is positive if the equipment shows its immunity, for the duration of the application of the test, and at the end of the tests the EUT fulfills the functional requirements established in the technical specification."

The user has to make this determination by observing the unit under test. At the end of the test, the GUI will pop up a dialog box asking the operator to assess the state of the EUT. If the EUT is still functional, the operator may answer Yes when prompted. If not, he should answer no. The response to this query is incorporated as a PASS or FAIL result in the test report.



13.7 IEC 61000-4-29 Test Reports

At the end of a test run, the operator can generate a test report by clicking on the "Print report" button. IEC 61000-4-29 test reports include all test setup information and test results. User provided information at the bottom of the 4-29 screen is included as well.

The report format and test report headers can be selected from the Option, IEC Test Report menu but needs to be done before opening the IEC 429 test screen. The selected format (Printer, Text File or MS Word) applies to all IEC immunity tests. MS Word reports are automatically saved in the C:\Program Files\California Instruments\Cigui32\Reports or C:\Program Files\California Instruments\CiguiSII\Reports directory.

13.8 Source Requirements

The IEC 61000-4-29 imposes certain requirements on the DC test generator used. Not all of these requirements can be met with the iX Series AC/DC power source. The following restrictions apply:

Capability	**Standard Requirement**	**iX Series**	
Output voltage range	0 - 360 Vdc	0 - 300 Vdc	
Output voltage variations under load	< 5 %	< 1 %	
Ripple content	< 1 % of output voltage	< 1 V rms	
Rise and fall time into 100 Ohm resistive load	between 1 and 50 usec	0.3 V/usec	
Over/undershoot into 100 Ohm resistive load	< 10 %	< 2 %	
Output current, steady state	up to 25 A	3001iX 5001iX 10001iX	10 A 18.5 A 37.0 A

Note: The use of a test generator with higher or lower voltage or current capability is allowed provided that the other specifications are preserved. The test generator steady state power/current capability shall be at least 20 % greater than the EUT power/current ratings.

This means that for many EUT's a 25 A capable generator is not needed. However, since the rise and fall time requirements may not be met under all circumstances, this is a pre-compliance test only.

For full compliance test applications, the test generator must be tested for compliance with the test generator requirements.

14. Customizing IEC 61000-4 Test Parameters

14.1 About This Chapter

This chapters covers describes how to modify aspects of IEC 61000-4 immunity testing to accommodate different product committee requirements.

The available 61000-4 tests implemented in the CIGui32 or CIGuiSII program are based on the most recent officially published test standard. Future changes in test levels can be accommodated without the need to upgrade the CIGui32 or CIGuiSII program. To allow for some level of customization, the CIGui32 or CIGuiSII will accept different test parameters that can be edited by the user.

14.2 IEC 61000-4-11 Implementations

There are two versions of the IEC 61000-4-11 test in the CIGui32, one for iX Series AC Sources with the -411 and / or the EOS option and one for iX Series that lack the -411 option. The .411 file shown below applies to the latter implementation. The -411 firmware option based implementation uses files with extension .411_Dips and .411_Vars. Both test file formats can be edited on screen within the CIGUI32 program and saved back to disk.

Note that the CIGuiSII only support the –411 option based IEC 61000-4-11 tests.

14.2.1 IEC411.411 File

[IEC-1000-4-11]	IEC 61000-4-11 section header
	Parameters that apply to both Dips and Variations
SeqRepeat = 3	Number of times each voltage fluctuation is repeated. Range 1 to 60.
SeqDuration = 10	Time between successive dips and variations. The standard specifies this time to be no less than 10 seconds.
InterSeqDelay = 1	Time between each run of dips or variations. This time should be at least 1 second and no more than 60 seconds.
UserPromt=	"User intervention required. Press OK when ready to continue"*(message displayed when GapDelay0 <0)*
MeasUpdateRate = 1000	Interval for updating measurement data in milliseconds. Range 100 to 60000 milliseconds.
	Parameters that apply only to Voltage Dips
SeqNumberDips = 21	Number of sets of dips. Each set consists of SeqRepeat dips. Each set has its own set of three parameters which follow. each parameter has a sequence number from 0 through SeqNumberDips-1. They do not have to be entered in any order.
CycleTime0 = 0.5	For each set number 0 through SeqNumberDips-1, the duration of the dip in AC cycles.
StartPhase0 = 0	For each set number 0 through SeqNumberDips-1, the start phase angle of the dip
TestLevel0 = 0	For each set number 0 through SeqNumberDips-1, the voltage level to dip to in % of U nominal
GapDelay0=-1	-1 sets the user prompt. If >0 it sets the delay between dips.
	Parameters that apply to Voltage Variations
FallTimeVar = 2	Voltage fall time in seconds. Must be between 1 and 999 seconds
HoldTimeVar = 1	Voltage hold time in seconds. Must be between 1 and 999 seconds
RiseTimeVar = 2	Voltage rise time in seconds. Must be between 1 and 999 seconds
VarLevel0 = 40	First voltage level to change to in percent of U nominal
VarLevel1 = 0	Second voltage level to change to in percent of U nominal

User Prompts

Some EUT's will require resetting and readjustment when the power dips or is interrupted for a long period. If this is the case, then set GapDelay0 = -1. This will cause the test sequence to halt and wait for user intervention. When ready to resume test press “OK”.

14.2.2 IEC413.413 File

[IEC-1000-4-13]	**IEC 61000-4-13 section header**
	Parameters that apply only to Flat Top Curve
Fcurv_lev = 90	Flat Curve Level at 90%
Fcurv_dwe = 120	Flat Curve Dwell time in seconds
Fcurv_pau = 5	Flat Curve Pause in seconds
	Parameters that apply only to Over Swing Curve
Oswcurv_dwe = 120	Over Swing Curve Dwell time in seconds
Oswcurv_pau = 5	Over Swing Curve Pause in seconds
Oswcurv3_lev = 6	Over Swing Curve of third harmonic level at 6%
Oswcurv3_phs = 180	Over Swing Curve of third harmonic phase test of 180 degrees
Oswcurv5_lev = 4	Over Swing Curve of fifth harmonic level at 4%
Oswcurv5_phs = 0	Over Swing Curve of fifth harmonic phase test of 0 degree
	Parameters that apply to Frequency Sweep
Swefreq1_lev = 3	Sweep Frequency Level of first range at 3%
Swefreq2_lev = 10	Sweep Frequency Level of second range at 10%
Swefreq3_lev = 5	Sweep Frequency Level of third range at 5%
Swefreq4_lev = 5	Sweep Frequency Level of fourth range at 5%
Swefreq5_lev = 2	Sweep Frequency Level of fifth range at 2%
Swefreq_dwe = 300	Sweep Frequency Dwell time in seconds
Swefreq1_stp = 5	Sweep Frequency Step size of first range in Hz
Swefreq2_stp = 10	Sweep Frequency Step size of second range in Hz
Swefreq3_stp = 10	Sweep Frequency Step size of third range in Hz
Swefreq4_stp = 10	Sweep Frequency Step size of fourth range in Hz
Swefreq5_stp = 25	Sweep Frequency Step size of fifth range in Hz
	Parameters that apply only to Individual Harmonics
Indharm2_lev = 3	Individual harmonics Level for nth (second) harmonic in %
Indharm2_phs = 0	Individual harmonics Phase for nth (second) harmonic in degree
Indharm_dwe = 5	Individual harmonics Dwell time in second
Indharm_pau = 5	Individual harmonics Pause in second
	Parameters that apply only to Interharmonics
Interharm1_lev = 2.5	Interharmonics Level for first range at 2.5%
Interharm2_lev = 5	Interharmonics Level for second range at 5%
Interharm3_lev = 3.5	Interharmonics Level for third range at 3.5%
Interharm4_lev = 2	Interharmonics Level for fourth range at 2%
Interharm5_lev = 1.5	Interharmonics Level for fifth range at 1.5%
Interharm_dwe = 5	Interharmonics Dwell time in second
Interharm_pau = 1	Interharmonics Pause in second

14.3 Sample File IEC411.411

The CIGUI32 program supports two different implementations of the IEC 61000-4-11 standard. One is based on the -411 firmware option. This version does not use an ini file but stored test sequences in a proprietary format instead. If your system uses an iX Series AC power source but does not have the -411 option installed, the following IEC411.411 file is used to store the test sequence. You can create additional files with the .411 extension and save them in the

C:\Program Files\California Instruments\Cigui32\IEC_Test directory.

Note that the CIGuiSII program only supports the –411 option based tests.

Following is a listing of the default IEC411.411 file shipped with the CIGUI32 program. If for some reason your 411 file is lost or you would like to restore it to its original condition, use the values shown here.

[IEC-1000-4-11]
PreTest = 3
SeqRepeat = 3
SeqDuration = 10
InterSeqDelay = 1
UserPrompt = User intervention required. Press OK when ready to continue
SeqNumberDips = 21
MeasUpdateRate = 1000
CycleTime0 = 0.5
StartPhase0 = 0
TestLevel0 = 0
GapDelay0 = 2
CycleTime1 = 0.5
StartPhase1 = 180
TestLevel1 = 0
GapDelay1 = 2
CycleTime2 = 1
StartPhase2 = 0
TestLevel2 = 0
GapDelay2 = 5
CycleTime3 = 5
StartPhase3 = 0
TestLevel3 = 0
GapDelay3 = 2
CycleTime4 = 10
StartPhase4 = 0
TestLevel4 = 0
GapDelay4 = 2
CycleTime5 = 25
StartPhase5 = 0
TestLevel5 = 0
GapDelay5 = 2
CycleTime6 = 50
StartPhase6 = 0
TestLevel6 = 0
GapDelay6 = 2
CycleTime7 = 0.5
StartPhase7 = 0
TestLevel7 = 40
GapDelay7 = 2
CycleTime8 = 0.5
StartPhase8 = 180
TestLevel8 = 40
GapDelay8 = 2
CycleTime9 = 1
StartPhase9 = 0
TestLevel9 = 40
GapDelay9 = 2
CycleTime10 = 5
StartPhase10 = 0
TestLevel10 = 40
CycleTime11 = 10
StartPhase11 = 0
TestLevel11 = 40
CycleTime12 = 25
StartPhase12 = 0
TestLevel12 = 40
CycleTime13 = 50
StartPhase13 = 0
TestLevel13 = 40
CycleTime14 = 0.5
StartPhase14 = 0
TestLevel14 = 70
CycleTime15 = 0.5
StartPhase15 = 180
TestLevel15 = 70
CycleTime16 = 1
StartPhase16 = 0
TestLevel16 = 70
CycleTime17 = 5
StartPhase17 = 0
TestLevel17 = 70
CycleTime18 = 10
StartPhase18 = 0
TestLevel18 = 70
CycleTime19 = 25
StartPhase19 = 0
TestLevel19 = 70
CycleTime20 = 50
StartPhase20 = 0
TestLevel20 = 70

FallTimeVar = 2
HoldTimeVar = 1
RiseTimeVar = 2
VarLevel0 = 40
VarLevel1 = 0

14.4 Sample File IEC413.413

Following is a listing of the default IEC411.413 file shipped with the CIGUI32 program. If for some reason your 413 file is lost or you would like to restore it to its original condition, use the values shown here.

```
[IEC-1000-4-13 / Class 2]

[Flat Curve test]
FCURV_LEV=90
FCURV_DWE=120
FCURV_PAU=5

[Over Swing Curve test]
OSWCURV_DWE=120
OSWCURV_PAU=5
OSWCURV3_LEV=6
OSWCURV3_PHS=180
OSWCURV5_LEV=4
OSWCURV5_PHS=0

[Sweep Frequency test]
SWEFREQ1_LEV=3
SWEFREQ2_LEV=10
SWEFREQ3_LEV=5
SWEFREQ4_LEV=5
SWEFREQ5_LEV=2
SWEFREQ_DWE=300
SWEFREQ1_STP=5
SWEFREQ2_STP=10
SWEFREQ3_STP=10
SWEFREQ4_STP=10
SWEFREQ5_STP=25

[Individual Harmonic test]
INDHARM2_LEV=3
INDHARM2_PHS=0
INDHARM3_LEV=8
INDHARM3_PHS=0
INDHARM4_LEV=1.5
INDHARM4_PHS=No test
INDHARM5_LEV=9
INDHARM5_PHS=0
INDHARM6_LEV=No test
INDHARM6_PHS=No test
INDHARM7_LEV=7.5
INDHARM7_PHS=0
INDHARM8_LEV=No test
INDHARM8_PHS=No test
INDHARM9_LEV=2.5
INDHARM9_PHS=No test
INDHARM10_LEV=No test
INDHARM10_PHS=No test
INDHARM11_LEV=5
INDHARM11_PHS=No test
INDHARM12_LEV=No test
INDHARM12_PHS=No test
INDHARM13_LEV=4.5
INDHARM13_PHS=No test
INDHARM14_LEV=No test
INDHARM14_PHS=No test
INDHARM15_LEV=No test
INDHARM15_PHS=No test
INDHARM16_LEV=No test
INDHARM16_PHS=No test
INDHARM17_LEV=3
INDHARM17_PHS=No test
INDHARM18_LEV=No test
INDHARM18_PHS=No test
INDHARM19_LEV=2
INDHARM19_PHS=No test
INDHARM20_LEV=No test
INDHARM20_PHS=No test
INDHARM21_LEV=No test
INDHARM21_PHS=No test
INDHARM22_LEV=No test
INDHARM22_PHS=No test
INDHARM23_LEV=2
INDHARM23_PHS=No test
INDHARM24_LEV=No test
INDHARM24_PHS=No test
INDHARM25_LEV=2
INDHARM25_PHS=No test
INDHARM26_LEV=No test
INDHARM26_PHS=No test
INDHARM27_LEV=No test
INDHARM27_PHS=No test
INDHARM28_LEV=No test
INDHARM28_PHS=No test
INDHARM29_LEV=1.5
INDHARM29_PHS=No test
INDHARM30_LEV=No test
INDHARM30_PHS=No test
INDHARM31_LEV=1.5
INDHARM31_PHS=No test
INDHARM32_LEV=No test
INDHARM32_PHS=No test
INDHARM33_LEV=No test
INDHARM33_PHS=No test
INDHARM34_LEV=No test
INDHARM34_PHS=No test
INDHARM35_LEV=1.5
INDHARM35_PHS=No test
INDHARM36_LEV=No test
INDHARM36_PHS=No test
INDHARM37_LEV=1.5
INDHARM37_PHS=No test
INDHARM38_LEV=No test
INDHARM38_PHS=No test
INDHARM39_LEV=No test
INDHARM39_PHS=No test
INDHARM40_LEV=No test
INDHARM40_PHS=No test
INDHARM_DWE=5
INDHARM_PAU=1

[Interharmonics test]
INTERHARM1_LEV=2.5
INTERHARM2_LEV=5
INTERHARM3_LEV=3.5
INTERHARM4_LEV=2
INTERHARM5_LEV=1.5
INTERHARM_DWE=5
INTERHARM_PAU=1
```

15. Specifications

15.1 About This Chapter

This chapters provides the technical specifications of the CTS measurement system and the Power Analysis and Conditioning System unit (PACS-1. PACS-3 and PACS-3-75). If the CTS system you have includes an AC power source, refer to the separate AC source user manual that shipped with the AC source.

Note: All specifications listed in the manual are valid at an ambient temperature of 23° ± 5° and apply after a 15 minute warm-up period.

15.2 Measurement System Specifications

The CTS measurement system is implemented using a high speed Analog to Digital ISA plug in board. This board needs to be installed properly in order to function according to the specification listed here.

Measurement		Specification	Unit
Bandwidth			
	Anti Aliasing	> 60 dB at 5 KHz	
	Bandpass ripple	< 2 % up to 2.5 KHz	%
Volts			
	Range	0.01 - 312.00	V_{rms}
	Max. input	1000	V_{peak}
	Max. crest factor	5:1	
	Accuracy	± 0.1 % ± 0.05 % FS ± 3 mV	mV
	Resolution	10	mV
	Voltage CMRR	80	dB
RMS Current			
	Current ranges (Auto ranging)	4,16,40	A_{rms}
	Current ranges (Auto ranging) -75	4,16,75	A_{rms}
	Highest range PACS-1 / PACS-3	40.00	A_{rms}
	Highest range PACS-3-75	75.00	A_{rms}
	Max. input [permanent, no damage if < 200 A_{peak}] PACS-1 / PACS-3	40.00	A_{rms}
	Max. input [permanent, no damage if < 200 A_{peak}] PACS-3-75	75.00	A_{rms}
	Max. Crest Factor [High Range]	5:1	
	Max. Crest Factor [High Range] -75	2.5:1	
	Max. Crest Factor [Low Range]	20:1	
	Accuracy	± 0.1 % ± 0.05 % FS ± 3 mA	mA
	Resolution	1	mA

Measurement			Specification	Unit
Power				
	Range PACS-1 / PACS-3		0.1 - 12,500	W/ph
	Range PACS-3-75		0.1 - 22,500	W/ph
	Accuracy		± 0.25 % ± 0.25 % FS ± 20mW	mW
	Resolution		0.1	W
Apparent Power				
	Range PACS-1 / PACS-3		0.01 - 12,500	VA/ph
	Range PACS-3-75		0.01 - 22,500	VA/ph
	Accuracy		± 0.15% ± 0.15% FS ± 20	mVA
	Resolution		0.01	VA
Power Factor				
	Range		0.00 - ± 1.00	
	Accuracy		± 0.05	
	Resolution		0.01	
Crest Factor				
	Range		20:1	
	Accuracy		± 0.005	
	Resolution		0.001	
Frequency				
	Range		45 - 65	Hz
	Accuracy		0.1 % of reading	Hz
	Resolution		0.1	Hz
Harmonic Analysis				
	Range		Fundamental to 40^{th}	
	Accuracy Fundamental		±0.05% FS±0.05%/kHz	
	Accuracy Harmonics		±0.1 %±0.1%/kHz	
	Measurement window		10, 12 or 16 periods	
	Smoothing filter		1.5	sec
Flicker				
	Pst	Range	0.1 - 10	Pst
		Accuracy	3	%
		Resolution	0.01	
		Integration time	10	min
	Plt	Range	0.1 - 10	
	d_{max}	Range	0 - 100	%
	d_c	Range	0.1 - 100	%
	d_t	Range	0.1 - 100	%
	d_t over3%(4%)	Range	0 - 1000	ms

15.3 PACS Specification

The PACS unit creates the mechanical and electrical interface between the AC source, the EUT and the PC. It provides the necessary isolation and signal conditioning to perform the measurements needed.

PACS units are available in single and three phase configurations. Single phase CTS systems are supplied with a PACS-1 single phase unit, three phase CTS systems are supplied with a PACS-3 or PACS-30-75 three phase unit.

The following specifications apply to the PACS units.

PACS Model:		PACS-1	PACS-1-75	PACS-3	PACS-3-75
Number of phases		1	1	3	3
Channels	Voltage and Current	2	2	6	6
Connector Style	Front panel	CEE/77 front	none	none	none
	Rear panel	terminal block	terminal block	terminal block	terminal block
Maximum Voltage	Front panel	240 Vac	n/a	n/a	n/a
	Rear panel	312 Vac	312 Vac	480 Vac	480 Vac
Maximum Current	Front panel	16A rms	n/a	n/a	n/a
	Rear panel	40A rms	75A rms	40A rms/phase	75A rms/phase
Built-in Reference Impedance	1251RP-CTS 5001iX-CTS	internal option	n/a	n/a	n/a
Input Voltage	Rear panel	115V / 230V Nominal ± 10%	115V / 230V Nominal ± 10%	115V / 230V Nominal ± 10%	115V / 230V Nominal ± 10%
Input Frequency	IEC 320	50 / 60Hz	50 / 60Hz	50 / 60Hz	50 / 60Hz
Input Current		less than .6A (115v) less than .3A (230v)	less than .6A (115v) less than .3A (230v)	less than .6A (115v) less than .3A (230v)	less than .6A (115v) less than .3A (230v)
Dimensions	HxWxD (inch)	3.5 x 16.8 x 22	3.5 x 16.8 x 22	3.5 x 16.8 x 22	3.5 x 16.8 x 22
	HxWxD (mm).	89 x 427 x 560	89 x 427 x 560	89 x 427 x 560	89 x 427 x 560
Weight	Lbs / kg with Ref Imp.	12 / 5.4 21 / 9.5	12 / 5.4	12 / 5.4	12 / 5.4

Table 15-1 PACS Specifications

Voltage Range: The input voltage range is 0 to 312V rms.
The 1-phase or 3-phase voltage is applied to input terminal block TB4.

Current Range: The max. input current is 40A rms for PACS-1 and PACS-3.
The max. input current is 75 A rms for PACS-1-75 and PACS-3-75.

PACS-1 Front panel outlet current rating is 16A rms. only.
Voltage can be 0 to 312V rms.

Frequency may not be 50Hz depending on power source used and application.

15.4 Environmental

Parameter	Specification
Operating Temp:	0 degrees to +40 degrees Celsius.
Storage Temp:	0 degrees to +70 degrees Celsius.
Humidity:	
Operating:.	≤90% RH up to 40° C
Storage:	≤90% RH up to 40° C, ≤75% RH up to 70° C.
Creepage and	
Clearance:	Rated for Pollution Degree 2.
Insulation:	Rated to Installation Category(Overvoltage Category) II
Vibration:	Designed to meet NSTA 1A transportation levels.
Shock:	Designed to meet NSTA 1A transportation levels.

15.5 Regulatory

Parameter	Specification
Electromagnetic Emissions and Immunity:	Designed to meet EN50081-1 and EN50082-1 European Emissions and Immunity standards as required for the “CE” mark.
Acoustic Noise:	60 dBA maximum. Measured at one meter. (PACS-X or 1251RP) 75 dBA maximum. Measured at one meter. (5001iX)
Safety:	Designed to meet EN61010-1 European safety standards as required for the “CE” mark.

15.6 Flicker Reference Impedance

Flicker measurements require the use of a reference impedance according to IEC 725. Since this reference impedance has to be matched to the output of the AC source used, the PACS-1 is available in different versions to accommodate the different AC sources that may be part of the CTS system. The following reference impedances are available:

Model	Phases	Flicker Impedance
PACS-1RP	1	For RP Series based CTS system. Single phase lumped impedance built into PACS-1 cabinet.
PACS-1	1	For 3001iX-CTS and 5001iX-CTS using programmable impedance. (Standard)
Option -LR1	1	For 3001iX-CTS and 5001iX-CTS using optional lumped impedance. (Single phase lumped impedance built into PACS-1 cabinet.)
PACS-3	3	For 15003iX-CTS using programmable impedance. (Standard)
Option -LR3	3	For 15003iX-CTS using optional lumped impedance. (Three phase lumped impedance provides through OMNI-3-18i cabinet.)
Option -LR4	3	For 30003iX-CTS using lumped impedance. (Three-phase lumped impedance provides through OMNI-3-37i cabinet.)
Option -LR5	3	For single phase testing of EUT's at 100 V L-N for the Japanse flicker test standard, an OMNI-1-37iJ is available as option -LR5.

15.6.1 Single Phase Reference Impedance

The CTS systems based on the ix Series use a programmable output impedance to meet the flicker reference impedance requirements. All non-ix Series based CTS systems require the use of an external reference impedance. Consult the factory for configuration information.

If the CTS system was supplied with a PACS-1RP (1251RP-CTS), the required single phase reference impedance is built into the PACS-1RP unit. In this case, you can select the reference impedance by putting the PACS unit in the Flicker mode by pressing the Mode switch on the front panel of the PACS unit. The LED will indicate Flicker (for Flicker testing) or Bypass (for Harmonics testing) mode. If the PACS-1 unit is configured for remote actuation of the flicker function, then the CTS 3.0 Software will switch from bypass to flicker automatically depending on what test is being run.

Reference Impedance	
Phases	1
Flicker Mode:	
Max. Current	18.5 A
Useable range	2.0 - 18.5 A
Bypass Mode:	
Max. Current	40.0 A
Impedance @ 50 Hz in Flicker Mode:	
Phase	0.24 + j0.15 Ω
Neutral	0.16 + j0.10 Ω
Accuracy	< 5 %
Controls and Indicators	
	Flicker On/Off push button
	Power Led
	Bypass mode Led
	Flicker mode Led

15.6.2 Three Phase Reference Impedances

The 15003iX-CTS three phase system by default uses the programmable impedance . Optionally, the OMNI-3-18i lumped impedance can be used. This separate 3.5 inch / 89 mm tall rack mount unit needs to be connected between the output terminals of the AC source and the input terminals of the PACS-3 unit. The OMNI-3-18i can be controlled from its front panel but is normally under control of the CTS 3.0 software.

The 30003iX-CTS system does not provide programmable impedance and therefore must be ordered with the OMNI-3-37i lumped reference impedance in order to support Flicker testing. The OMNI-3-37i is housed in a 5.25 inch / 133 mm tall 19 inch / 483 mm wide rack mount cabinet.

Refer to the OMNI or iX AC/DC Power Source user manual for details.

16. Configuration Options

16.1 About this Chapter

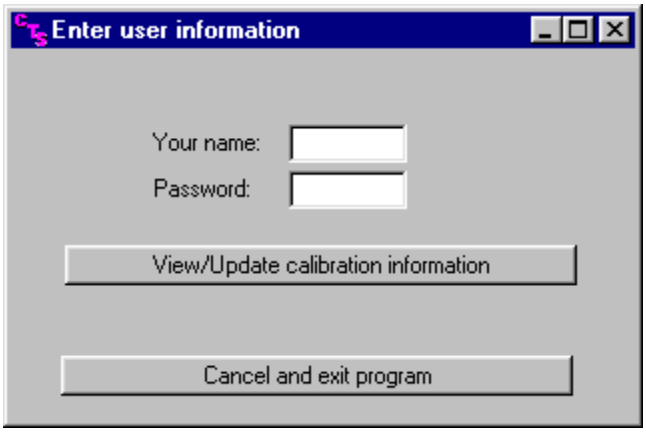
The CTS 3.0 software allows many parameters and operational characteristics to be customized to meet changing test standards and standard interpretations. Rather than providing a rigid programmed method, most of the operational characteristics such as IEC test limits, test window times and filter characteristics are data base driven.

A skilled operator may access the data in this data base and customize the system to his or her specific needs. Furthermore, if changes occur in one or more of the applicable test standards, it is possible to incorporate such changes without the need to upgrade the software version.

The Calibration and Configuration module is a separate program utility which is distributed as part of the CTS 3.0 software suite and may be used to access the configuration data base. It is located in the CTS 3.0 program directory. This chapter covers the configuration parameters only. For information on calibration settings and period calibration, refer to chapter 0.

16.2 Accessing the Calibration and Configuration Database

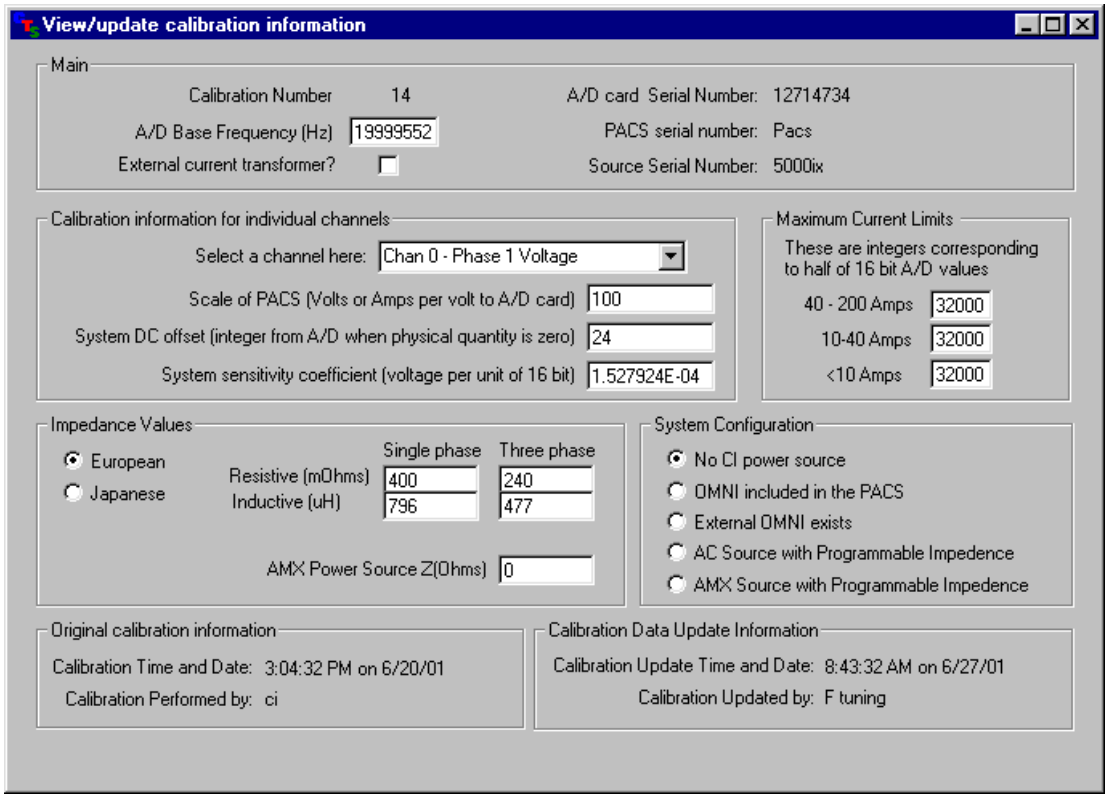
The Configuration utility is provided to allow the operator to view calibration and configuration parameters contained in this database. Only authorized users can change any of these values if properly logged in. Upon launching the Configuration.exe program, you will be prompted for your name and password. A history of all users and dates at which the configuration data has been changed is retained for audit purposes.



The correct password is "cal_lock". If no password or an incorrect password is specified, the operator can only view configuration data but not change any of it. After entering the correct name and password, the data can be both viewed and changed if needed. Click on the View/Update Limit Information button to access the configuration database.

16.2.1 Calibration and Configuration Data

The following calibration and configuration data is available to the user. If the correct password has been entered, this information can be updated. If not, it can only be viewed. Any changes will be logged and time stamped so an audit trail is available.


View/update calibration information
Main
Calibration Number 14
A/D Base Frequency (Hz) 19999552
External current transformer?
A/D card Serial Number: 12714734
PACS serial number: Pacs
Source Serial Number: 5000ix
Calibration information for individual channels
Select a channel here: Chan 0 - Phase 1 Voltage
Scale of PACS (Volts or Amps per volt to A/D card) 100
System DC offset (integer from A/D when physical quantity is zero) 24
System sensitivity coefficient (voltage per unit of 16 bit) 1.527924E-04
Maximum Current Limits
These are integers corresponding to half of 16 bit A/D values
40 - 200 Amps 32000
10-40 Amps 32000
<10 Amps 32000
Impedance Values
European
Japanese
Single phase
Three phase
Resistive (mOhms) 400 240
Inductive (uH) 796 477
AMX Power Source Z(Ohms) 0
System Configuration
No CI power source
OMNI included in the PACS
External OMNI exists
AC Source with Programmable Impedence
AMX Source with Programmable Impedence
Original calibration information
Calibration Time and Date: 3:04:32 PM on 6/20/01
Calibration Performed by: ci
Calibration Data Update Information
Calibration Update Time and Date: 8:43:32 AM on 6/27/01
Calibration Updated by: F tuning

Field	Description
Main	Displays information on the A/D card and base sampling frequency.
Calibration information	Individual voltage and current channels have calibration coefficients, which are calculated automatically when running the Calibration module. (See section 0) Normally, there is no need to edit these values.
Maximum Current Limits	The CTS system uses three current ranges for maximum resolution and accuracy of current harmonics measurements. The range coefficients are used to set the cross over points of these current ranges. These values should not be change by the user.

Field	Description
Impedance	These fields set the flicker reference impedance values when using an iX Series with programmable impedance. Values used may differ between European and Japanese standards. The Japanese standard presently requires the use of the reference impedance for both harmonics and flicker tests. During harmonics tests, this will result in high voltage distortion. This conflict has not been resolved at this time. The programmable impedance values are different for single and three phase modes. This setting is only relevant if you select " CI Source with programmable impedance" in the System Configuration setting. If the AMX power source is used, the output impedance may have to be set to a value other than 0 using the Z (Ohms) field at the bottom of this section.
System Configuration	This setting determines if a reference impedance is used and if so, which type. Available choices are:
No CI power source	Select this option if you are not using a CI AC Source or have no OMNI impedance.
OMNI included with PACS	Select this option if you have a 1251RP-CTS system, a PACS-1RP or a PACS-LR1
External OMNI	Select this option if you have a OMNI-1-18I / LR1, OMNI-1-37 / LR2, OMNI-3-18I / LR3, OMNI-3-37I / LR4 or OMNI-1-37iJ / LR5.
CI Source with programmable impedance	Select this option if you have a standard iX Series CTS system with programmable impedance.
AMX Source	Select this option if you have a PPS AMX power source model. Use of this model requires that the programmable impedance values are set to match any lumped impedance that may be part of the system or to the correct IEC 60725 reference impedance values. This may require on-site calibration. The value must be set in the Z(Ohms) field of the Impedance section.
Original Calibration Information	Shows original calibration date of CTS system.
Calibration Data Update Information	Shows the last date the system calibration data was changed and by whom.

17. Calibration

17.1 About This Chapter

This chapter covers two basic functions: System calibration and system configuration. Single phase calibration is covered first and additional steps for three phase calibration are also covered. System configuration is then covered detailing the steps to properly set up the AC power source.

If the CTS system you have includes an AC power source, refer to the separate user manual that shipped with the AC source for service and calibration information.

17.2 Calibration

The CTS system uses a precision measurement system that requires periodic calibration. The recommended calibration interval is one year. All CTS systems are factory calibrated before shipment, so adjustment should not be needed until after the first year of use.

Note: For calibration at the factory, the A/D card must be returned with the PACS.

A special calibration program is included in the CTS 3.0 Software suite to facilitate calibration and store the calibration constants. This module is called "**Calibration**" and is available by clicking on the **Compliance Test System** menu selection. The program screen is shown on the next page. Make appropriate selection before clicking on the Calibrate button. Upon Clicking the Calibration button, you will be given step-by-step instructions to complete the calibration. At the end of a calibration, the Accept button will be available. Clicking on it will cause the software to save the calibration data and printout a calibration log file.

17.2.1 Required Calibration Equipment

To perform the CTS measurement system calibration, the following equipment is required:

Equipment	Description
Digital AC Multimeter	Agilent 34401A DMM or equivalent with traceable calibration.
Resistive Load Bank	Avtron K565 or equivalent. The load resistor range must be able to handle 2 - 30A rms (or higher for PACS-3-75) and be rated for the power levels used.
Current Shunt	50A Current shunt 0.05 % accuracy or better, e.g. Isotek.

Table 17-1: Required Calibration Equipment

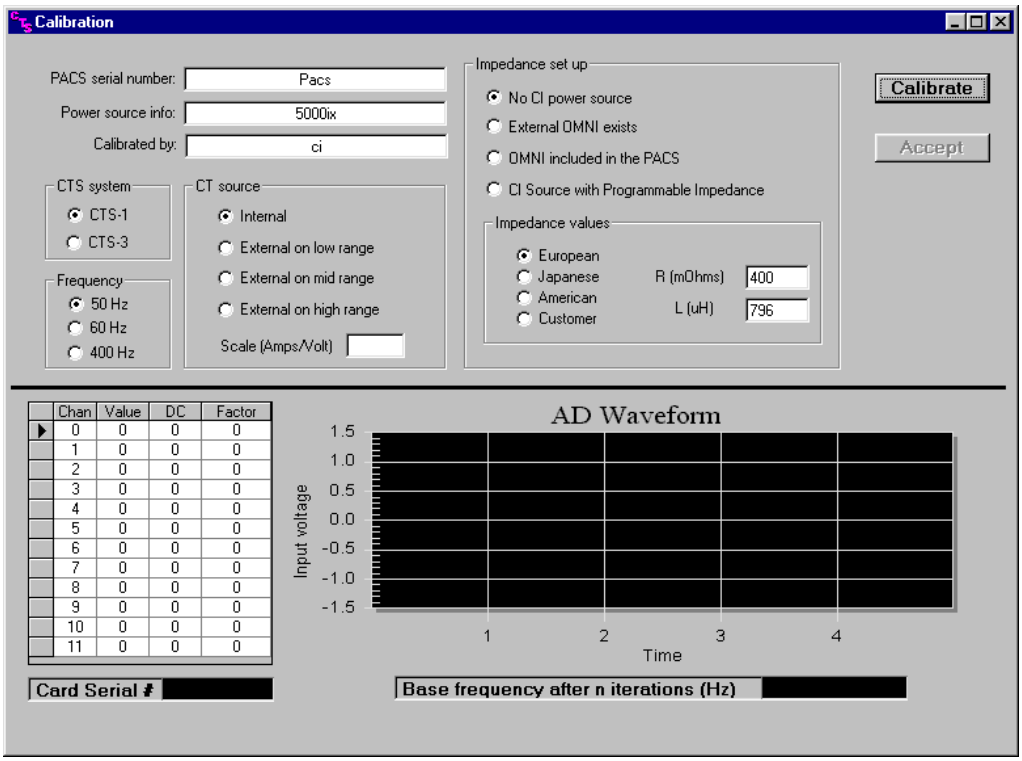


Figure 17-1 : CTS 3.0 Calibration Program Main Screen

17.3 Install A/D Card in PC

The PACS must be calibrated with the A/D PCI card that was supplied with the system. If the card is replaced, the system must be re-calibrated.

Install the PCI card into the test computer and connect it to the rear terminal of the PACS with the DB37-DB68 cable provided.

17.4 PACS-x Calibration Setup

To calibrate the CTS measurement system, proceed as follows:

1. For a single phase CTS system, configure the test set-up as shown in Figure 17-2. For a three-phase CTS system with or without a three-phase CI source, configure the test set-up as shown in Figure 17-3. Please note that only a single-phase A/C source is needed to calibrate a three-phase PACS unit.
2. Connect the current shunt or current transformer in series with the neutral wire between the PACS unit and the load bank.
3. Connect the Voltage DMM at the AC IN terminals on the PACS unit. (TB4)

17.5 Configuration Procedure

1. Start the Calibration module located in the **Compliance Test System** Program group called **Calibration** (See Figure 17-1).
2. Fill in the information for PACS serial #, Power source to be used for the calibration, and your name or ID. Make all other appropriate selections before clicking on the Calibrate button.
3. Once the Calibrate button is clicked, the software will prompt you to fill in a table recording the equipment and measurement instruments to be used for this calibration. When this is completed, the program will provide you with the step-by-step instructions. Follow these instructions until the Accept button is enabled. If you did not follow the instructions during the calibration or the software is aborted for some other reason, you may have to redo the entire calibration. Please note that the calibration data is not saved until the Accept button is pressed.
4. Please note that when calibrating a three-phase PACS, all three channels will be calibrated together. The software will do all three-voltage channels, all high current range channels, all mid-range channels, and then all low range channels.
5. When calibrating the voltage channels, you will be asked to provide a 230V/50Hz input. However, when calibrating the current channels, it is not necessary to keep the voltage input at the same level. In addition, the calibration on current channels is in the sequence of 40Arms/200App, 8Arms/40App, and 2Arms/10App. The software does not do auto ranging in the process. This means that even if you apply 2 Arms when you are doing 40Arms/200App range channel(s), the software will still perform the corresponding calibration. The drawback of doing so is that the calibration accuracy may be compromised.
6. When the Accept button becomes available and is clicked at the end of calibration, the software will save the data in text file with the name of “C:\CTS calibration.dat”. In addition, it will generate “calibrate.log” in the CTS directory and print out a hardcopy of this file automatically. It will also save the calibration information in a database. Further, it will ask you if you want to copy the calibration data to floppy. If you answer yes, it will perform all the copying for you automatically.
7. If you copied the calibration data to the floppy, remove disk from drive and write the PACS serial number on the floppy disk and keep for backup purposes.

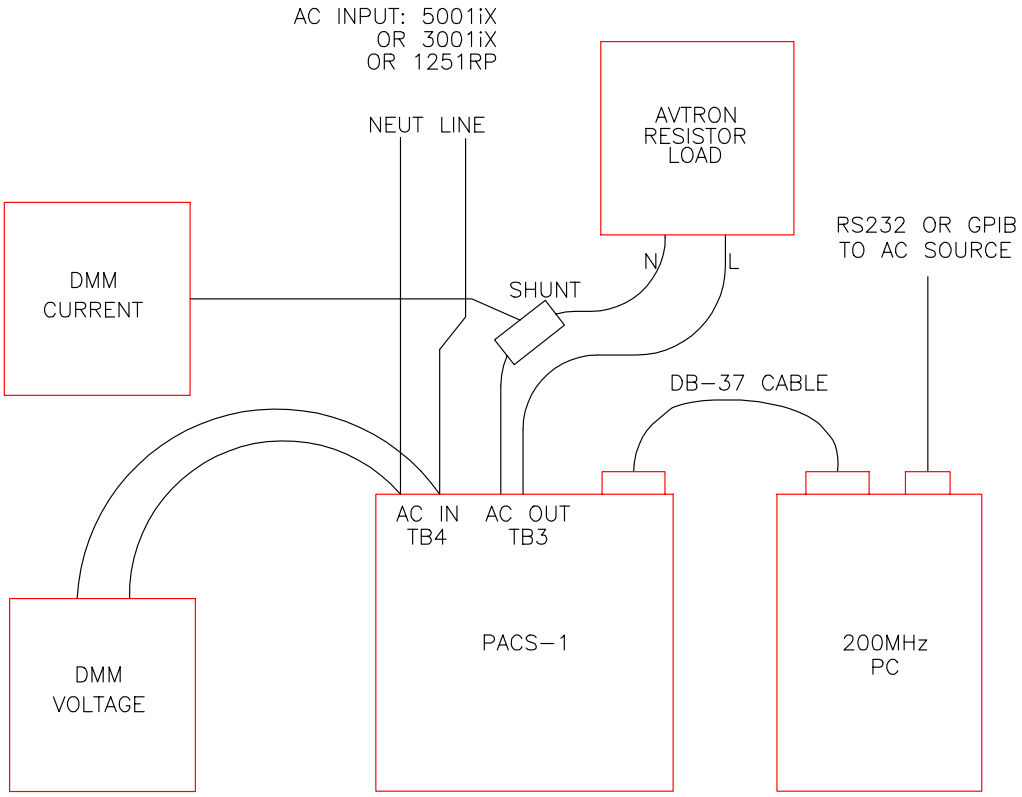


Figure 17-2: Single Phase Calibration Setup

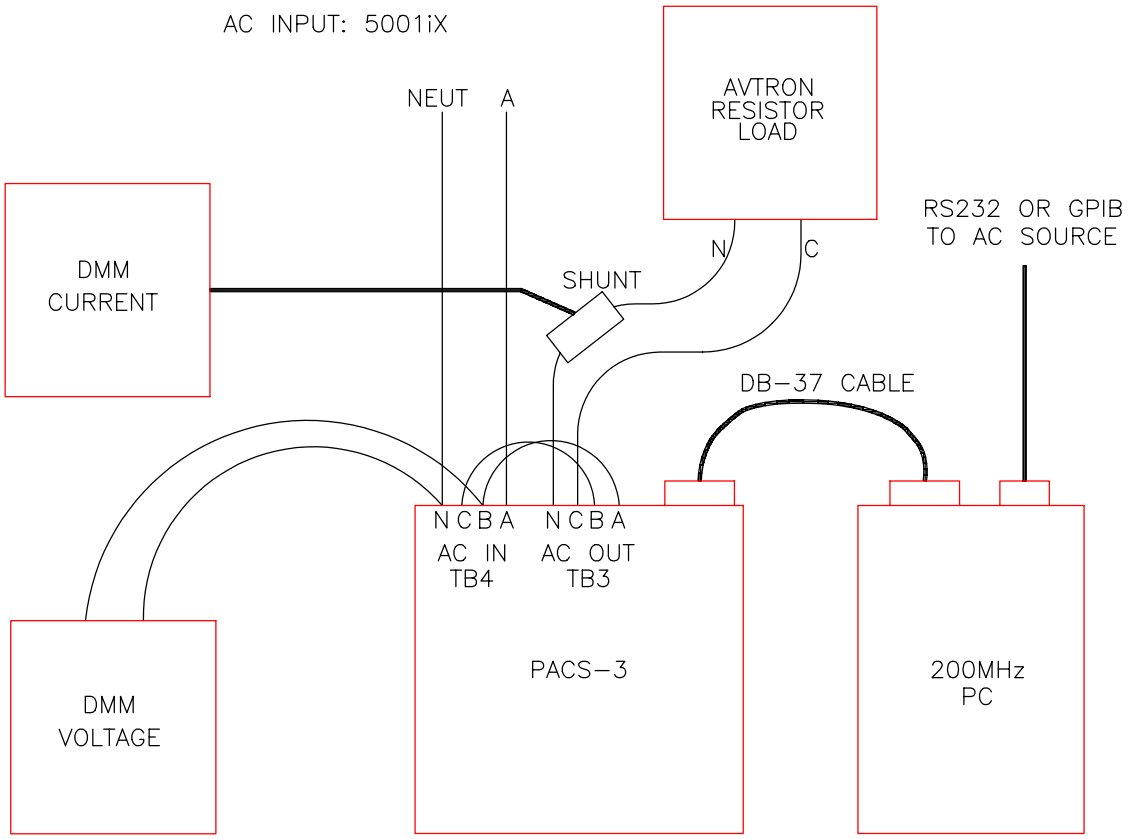


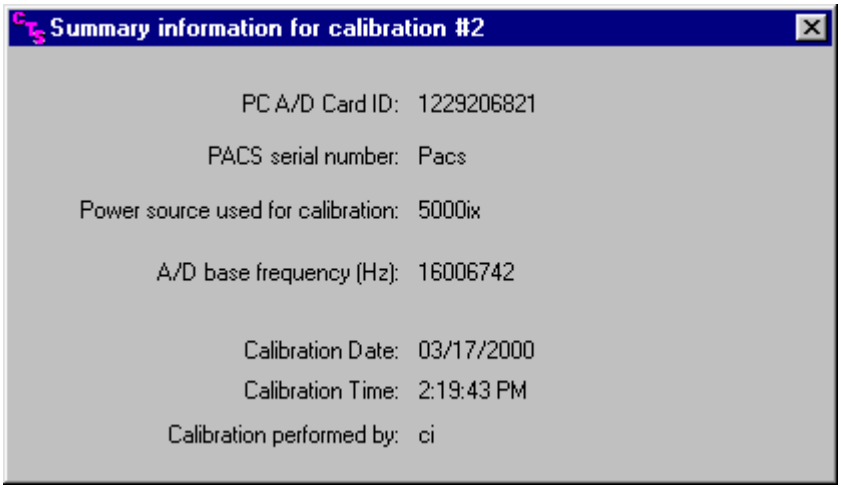
Figure 17-3: Three Phase Calibration Setup

17.6 Installing New CTS 3.0 Calibration Data

If you have send in the CTS 3.0 system for calibration at a remote calibration lab or at California Instruments, the PC normally used to run the CTS system will typically not have the new calibration on it when you receive the PACS and A/D card back. The new calibration data will be received on a removable medium such as a CD ROM or floppy disk or emailed to you as an alternative.

To install the new calibration data, proceed as follows:

1. Insert the calibration disk received into CD ROM or floppy drive as appropriate.
2. Open your Windows Explorer and select the drive.
3. Copy the CTS_Calibration.cts file located on the removable medium's root directory
4. Paste this file to the C:\ root of the PC that operates the CTS system.
5. Run the CTS 3.0 program. Upon launch, the CTS 3.0 program will detect the calibration data file which should have a newer date and time stamp that the calibration data currently in use. If so, the program will automatically read the new cal file and update its calibration data base.
6. You can verify that the new calibration data has been loaded by selecting the "View, Calibration Info" menu.


Summary information for calibration #2
PC A/D Card ID: 1229206821
PACS serial number: Pacs
Power source used for calibration: 5000ix
A/D base frequency (Hz): 16006742
Calibration Date: 03/17/2000
Calibration Time: 2:19:43 PM
Calibration performed by: ci

You can save the calibration disk if needed although annual re-calibration of the system is recommended.

18. Principle Of Operation

18.1 General

The Compliance Test System is a power measurement and power analyzer system. The three basic building blocks are:

- **AC power**, either line power or, typically, a CI power source to provide the proper voltage and frequency for the test at hand.
- **PACS-1 or PACS-3** measurement unit. This device measures the actual current and voltages under test and conditions the signals to be compatible with the Analog to Digital data conversion card.
- **CTS 3.0 Software**. The software is the final link to the user. It translates the data from the AD card into viewable and readable measurements in a GUI format.

18.2 AC Power

The AC power is the most flexible of the building blocks. It can be 1-phase or 3-phase and in some cases the users available line power is adequate. However, if more precise control of voltage and frequency is needed, as in IEC regulatory testing, the California Instruments mating power sources provide the proper accuracy and programmability for this task.

18.3 PACS1 or PACS3 Measurement Unit

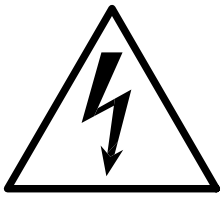
The PACS measurements module uses Hall Effect current sensors to isolate and scale a sense voltage that is an accurate and linear function of the current being measured. The sensing amplifiers uses differential sensing to reduce common mode noise pick-up before it is sent to the interface connector for transmission to the host PC.

To sense the applied voltage, another set of differential amplifiers are used together with high precision sense resistors to provide high CMRR. The sense resistors are of high enough impedance to limit any leakage current to under 0.5mA.

The PACS-1 module also has circuits that switch the built in impedance in and out of circuit for flicker compliance testing. If this optional impedance is not installed, the “flicker/bypass” button control has no function.

18.4 CTS 3.0 Software

The CTS 3.0 Software is designed to work with the data acquisition card’s digital samples of voltage and current. Numerous data channels are scanned sequentially and the software then calculates many parameters using Fast Fourier Transforms and displays them in the Graphical User Interface. In addition to numerical outputs of voltage current, power etc., the software also displays real time graphics of voltage and current.



CAUTION

VOLTAGES UP TO 480 VAC AND 650 VDC MAY BE PRESENT IN CERTAIN SECTIONS OF THE COMPANION POWER SOURCES. THIS EQUIPMENT GENERATES POTENTIALLY LETHAL VOLTAGES.

DEATH

ON CONTACT MAY RESULT IF PERSONNEL FAIL TO OBSERVE SAFETY PRECAUTIONS. DO NOT TOUCH ELECTRONIC CIRCUITS WHEN POWER IS APPLIED.

19. Service

19.1 Cleaning

The exterior of the power source or the PACS unit may be cleaned with a cloth dampened with a mild detergent and wrung out. Disconnect mains power before cleaning. Do not spray water or other cleaning agents directly at the equipment.

19.2 General

This section describes the suggested maintenance and troubleshooting procedure. The troubleshooting procedure is divided into two sections. The first section deals with basic operation and connection of the equipment. The second section requires opening the PACS unit and using the Test Points and a simple Digital Multimeter to troubleshoot the unit down to the circuit level. Only a qualified electronic technician should attempt this level of troubleshooting.

CAUTION: VOLTAGES UP TO 312 VAC MAY BE PRESENT IN CERTAIN SECTIONS OF THE PACS MEASUREMENT UNIT.

WARNING: THIS EQUIPMENT CONTAINS POTENTIALLY LETHAL VOLTAGES. DEATH ON CONTACT MAY RESULT IF PERSONNEL FAIL TO OBSERVE SAFETY PRECAUTIONS. DO NOT TOUCH ELECTRONIC CIRCUITS WHEN POWER IS APPLIED

19.3 Basic Operation

19.3.1 No Power To EUT

CONDITION	POSSIBLE CAUSE, REMEDY
No power to EUT	Line voltage or power source not at expected value. Verify power line voltage is correct. Verify power source voltage is at programmed value
AC source voltage OK. No power to EUT.	Incorrect input wiring at TB4. Check for wrong terminals or poor connections.
AC source voltage OK. Input wiring is OK. Still no power to EUT	Incorrect output wiring from TB3. Defective plug and cable from front panel outlet on PACS 1. Check output wiring from TB3, or, verify cable and plug going to EUT is good

19.3.2 Power Source Shuts Down

CONDITION	POSSIBLE CAUSE, REMEDY
The power source shuts down when the EUT load is applied	If the companion power source shuts down when the EUT load is applied, it is very likely that the power source is being severely overloaded. Any severe overload will cause the 1251RP or the 5001iX to immediately program itself to zero volts
The power source shuts down immediately when it is programmed to the test voltage	Another possible cause of shutdown is a short circuit in the EUT wiring or EUT load. Make sure neutral and line wires don't form a short circuit.

19.3.3 Power Source Overload Light On

CONDITION	POSSIBLE CAUSE, REMEDY
Overload light on power source is on	When the overload light is on, the power source is close to faulting or folding back the output voltage. Adjust EUT loading if possible to keep power source within its ratings.

19.3.4 No Signal To PC Interface

CONDITION	POSSIBLE CAUSE, REMEDY
EUT is being driven properly and voltage and current is present, but the CTS 3.0 Software GUI shows zero current or zero voltage.	The PACS front panel power switch is not on. Turn on switch, check ON LED. The ½ Amp input fuse is open. Replace fuse. The DB-37 interface cable is not seated in its mating connectors. Reinsert connectors. The Sensor Circuit board assembly inside the PACS module is defective. See next section.

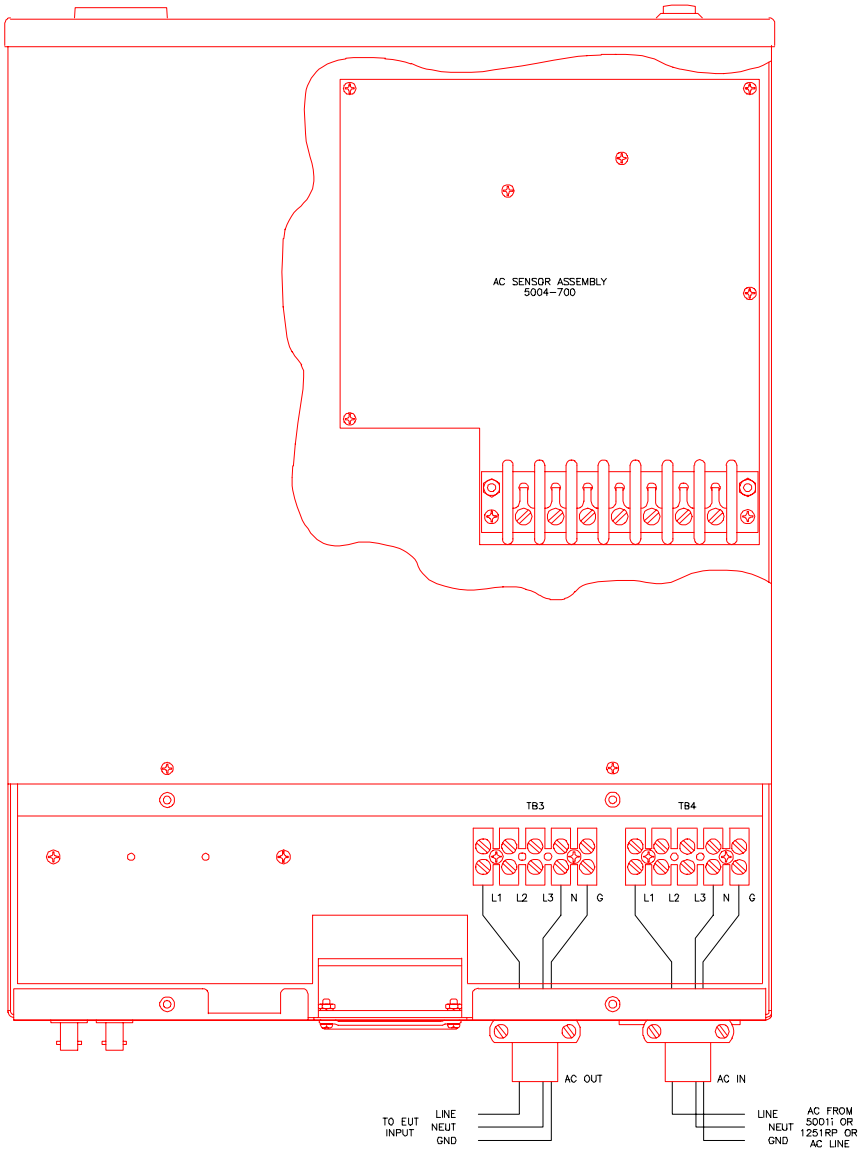


Figure 19-1: Location of AC Sensor Assy. 5004-700 in PACS-x

19.4 Advanced Troubleshooting

If it is suspected that the AC sensor circuit board inside the PACS unit is defective it will be necessary to remove the top cover of the unit and perform some basic tests to determine if the circuit is functioning properly. See Figure 33 for location.

CAUTION: VOLTAGES UP TO 312 VAC ARE PRESENT IN CERTAIN SECTIONS OF THIS POWER EQUIPMENT.

WARNING: THIS EQUIPMENT CONTAINS POTENTIALLY LETHAL VOLTAGES. DEATH ON CONTACT MAY RESULT IF PERSONNEL FAIL TO OBSERVE SAFETY PRECAUTIONS. DO NOT TOUCH ELECTRONIC CIRCUITS WHEN POWER IS APPLIED

19.4.1 Switch Off Unit, Disconnect High Voltage

Switch off the PACS unit with the front panel power on/off switch. Also disconnect or remove any AC voltage applied to the rear connection terminals TB3 and TB4.

19.4.2 Removing Top Cover

Remove the screws securing the top cover and remove the top cover.

19.4.3 Initial Inspection

Perform a visual inspection of the unit and ensure all the connectors are properly mated and there are no loose or broken wires. Check the interface cable going from the AC sensor assembly 5004-700 to the front and rear panels.

19.4.4 Power-On Troubleshooting - DC Supplies

WARNING: Do not touch any parts inside the unit during these tests as they will be live and dangerous. Always wear safety glasses.

1. Connect a DMM common test lead to TP1 on the 5004-700 AC sensor assembly. TP1 is the circuit common for all DC supplies and test signals. Connect the other DMM lead to the cathode of diode CR4.
2. Switch on the PACS unit with the front panel switch.
3. Verify the DC voltage at CR4-cathode is +15V.
4. Connect the other DMM lead to the anode of diode CR5.
5. Verify the DC voltage is -15V.
6. If either of these voltages are not as specified, the board will not function properly and will need to be serviced.

19.4.5 Power-On Troubleshooting - Voltage Sense

1. Connect the DMM common to TP1.
2. Connect the other DMM lead to TP2. This is the phase A voltage sense output.
3. Apply a test voltage to the PACS input terminals TB4. Use Neutral and ph- A
4. The reading at TP2 should be 1/100 of the input voltage. For example, if 120 V rms is applied at TB4, then there should be 1.20V rms at TP2.

PACS-3 ONLY

5. Connect the other DMM lead to TP3. This is the phase B voltage sense output
6. Apply a test voltage to the PACS input terminals TB4. Use Neutral and ph- B
7. The reading at TP3 should be 1/100 of the input voltage. For example, if 120 V rms is applied at TB4, then there should be 1.20V rms at TP3.
8. Connect the other DMM lead to TP4. This is the phase C voltage sense output
9. Apply a test voltage to the PACS input terminals TB4. Use Neutral and ph- C
10. The reading at TP4 should be 1/100 of the input voltage. For example, if 120 V rms is applied at TB4, then there should be 1.20V rms at TP4.
11. If any of these test points do not have the correct voltage on them, the board is malfunctioning and it must be serviced.

19.4.6 Power-On Troubleshooting - Current Sense

1. Connect the DMM common to TP1.
2. Connect the other DMM lead to TP6. This is the phase A current sense output.
3. Apply a 4A test current to the PACS input terminals TB4. Use Neutral and ph- A.
4. The reading at TP6 should be 496mV/ Amp of input current. For example, with 4.0A rms applied at TB4, then there should be 1.984V rms at TP6.

PACS-3 ONLY

5. Connect the other DMM lead to TP8. This is the phase B current sense output.
6. Apply a 4A test current to the PACS input terminals TB4. Use Neutral and ph- B.
7. The reading at TP8 should be 496mV/ Amp of input current. For example, with 4.0A rms applied at TB4, then there should be 1.984V rms at TP8.
8. Connect the other DMM lead to TP10. This is the phase C current sense output.
9. Apply a 4A test current to the PACS input terminals TB4. Use Neutral and ph- C.
10. The reading at TP10 should be 496mV/ Amp of input current. For example, with 4.0A rms applied at TB4, then there should be 1.984V rms at TP10.
11. If these sense voltages are not obtained then the board is malfunctioning and it must be serviced.

Index

2

24 x Dmax Test 86

A

A/D card 152
A/D Card
  I/O address 58
abort 82
AC Source 13
  control program 15
Acoustic 146
acquisition system 15
acquisition window 70
AD card
  specifications 143
AMX 151
AMX Power Source 76, 77
assumptions 11

C

calibration 152
  procedure 153
  required equipment 152
CE mark 146
CI400PCI 15
CI401PCI 15
CI403PCI 15
CIGui32 or CIGuiSII
  software installation 62
class A devices 70
class B devices 70
class C devices 70
class D devices 70
Class D wave shape 71
Classes
  IEC 1000-2-3 ..... 18, 22
compliance
  IEC 61000-4-11 94
components 12
Configuration
  Changing 149
  CTS 3.0 149
contents 6
controls
  flicker window 87
copyright 5
CTS
  components 12
  description 12
  software 11
current
  fundamental 82

D

description
  CTS 12
device class 70
disks
  distribution 61
display
  resolution 74
distribution disks 61

E

Electronic Output Switch 99
Emissions 146
EOS1 99
EOS3 99
ESD 45, 56
European Union 18

F

fields
  flicker window 87
flicker
  impedance 147
  three phase impedance 148
Flicker 24
  standard 24
fluctuations
  voltage 109
frequency
  variations 127
front panel 40

G

graph
  current harmonics 81
  voltage and current 81
  voltage harmonics 81
GUI 15

H

harmonic current limits
  dynamic 72
harmonics
  device class 70
  fluctuating 23
  quasi stationary 23
  stationary 23, 73
  testing 70
  transitory 23, 73
Harmonics
  IEC61000-4-7 23

I

I/O address 58
IEC 17
  address 28
  ANSI address 28
  directive 17
IEC 555-2 21
IEC 555-3 24
IEC 61000-3-2 21
IEC 61000-3-3 24
IEC 61000-4-11 ..... 25, 94
  compliance 94
  Edition 1.0 94
  Edition 2.0 94
  test results 99
  test setup 98
IEC 61000-4-14 ..... 26, 109
  test results 114
  test sequence 111
  test setup 110
IEC 61000-4-17 ..... 27, 116
  test results 118
  test sequence 117
  test setup 117
IEC 61000-4-27 ..... 27, 120
IEC 61000-4-28 ..... 27, 127
  test results 130
  test sequence 129
  test setup 128
IEC 61000-4-29 ..... 27, 132
IEC Tests
  INI File 139
  test parameters 139
IEC61000-4-7
  Inter Harmonics 23
IEEE-488
  Bus Controller 47, 60
Immunity 146
impedance
  flicker 24, 147
  reference 24, 147
  specifications 147
  three phase 148
INI File
  IEC Tests 139
installation 29
  CIGui32 62
  CTS 3.0 Software 61
ISA A/D Card
  configuration 56
  DIP switch 56
  Jumpers 56

J

jumpers
  JP11 57
  JP13 58

L

LED indicators 160
limits
  dynamic 72
  harmonic current 19
  IEC 61000-3-2 19

M

main window
  flicker 87
maintenance 160
manual
  history 3
  organization 11
measurements
  specifications 143

N

new 3

P

Pacific Power Source
  AMX 151
PACS 12, 14
  specifications 145
parameters
  IEC 1000-4 tests 139
PPS
  AMX 76, 77, 151
printing 3
  reports 82

R

reference impedance 24
references 28
resolution
  display 74
Ripple
  DC 116

S

Safety 146
sample CI-INI file 141, 142
Shock 146
software
  license 3
  revision 3
software installation
  CIGui32 or CIGuiSII 62
  Windows™ 61
software license 3
specifications 143
  measurements 143

PACS 145
status 40

T

Temperature
operating,storage 146
template 71
test
classes 18, 22
test data file
harmonics 82
test margin
flicker 90
harmonics 81
test parameters
IEC Test 139
test reports
IEC 61000-4-13 108
IEC 61000-4-29 137
test results
IEC 61000-4-11 99
IEC 61000-4-14 114
IEC 61000-4-17 118
IEC 61000-4-28 130
test sequence
IEC 61000-4-14 111
IEC 61000-4-17 117
IEC 61000-4-28 129
test setup
IEC 61000-4-28 128
test time
flicker 90
harmonics 81
top cover
removal 163
troubleshooting 160

U

unbalance
voltage 120
upgrading
CTS 1.X or 2.0 to CTS 3.0 64
user data
flicker 90
harmonics 81

V

variations
frequency 127
VGA
resolution 74
Vibration 146
voltage
DC Ripple 116
dips 94
fluctuations 109
interruptions 94
unbalance 120
variations 94

W

warranty 5
wave shape
class D 71
window
flicker 87
Windows
software installation 61
Word version 67